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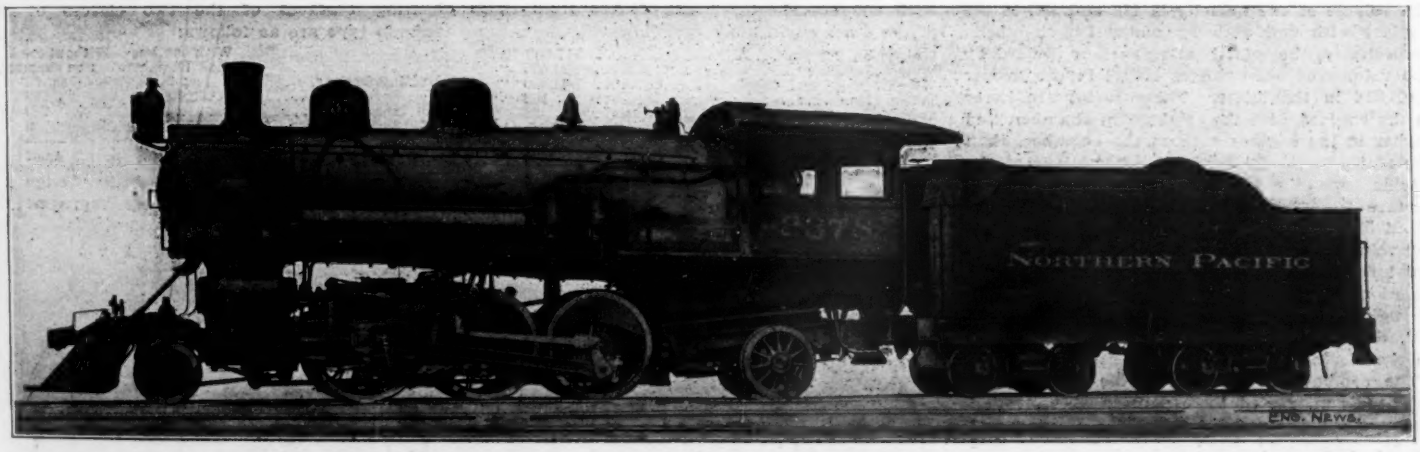
LOCOMOTIVE BOILERS WITH COMBUSTION CHAMBERS.

The use of combustion chambers in locomotive boilers, placed between the firebox proper and the tube sheet, has been many times suggested and various designs have been tried experimentally during the past 50 years. The main purposes of this arrangement are to ensure better combustion and an economy in fuel, and more especially to reduce the amount of boiler repairs consequent upon the action of the flame and the periodical attacks of cold air upon the tube sheet and the ends of the tubes. The most extensive use of combustion chambers has been in connection with the Wootten firebox for burning the small sizes of anthracite, but they have also been successfully employed on engines using bituminous coal; the most recent and important developments have been on engines using this latter class of coal, as noted below. The results of experience have been largely satisfactory, but the additional expense of special construction and the general tendency to conservatism in the adoption of radical changes in design are among the reasons why the combustion-chamber boiler has not yet come into more extended use.



PRAIRIE TYPE (2-6-2) LOCOMOTIVE, WITH COMBUSTION-CHAMBER BOILER AND WALSCHAERT VALVE GEAR; NORTHERN PACIFIC RY.

David Van Alstyne, Mechanical Superintendent. American Locomotive Co., New York, N. Y., Builders.

NORTHERN PACIFIC RY.

Within the past two years the most important development in this type of boiler has occurred on the Northern Pacific Ry., and for engines burning bituminous coal. As the result of extensive experiments undertaken by Mr. David Van Alstyne, Mechanical Superintendent, orders were given some months ago for no less than 70 engines of different types, all fitted with combustion chambers. The object of the design in this case was primarily to reduce the expenses and troubles (including engine failures) due to leaky tubes, especially in districts where the engines have to use bad water, and in this respect the engines appear to have been entirely successful. A report of the condition of the boiler of the first engine as determined by an inspection made by Mr. Van Alstyne, immediately after the engine had been cooled off, goes to justify his claims as to the advantages of the combustion chamber. The brick arch was in place, the tubes showed very little indication of leaking or of having had work done on them, the bottom tubes were opened and not choked, and the combustion chamber showed no signs of overheating and was free from ashes. Only one engine failure due to leaky tubes was reported against this engine during one year's service on the Yellowstone Division, where the water conditions are notoriously bad, and it is stated that only about 25% as much tube expanding was done on this engine as on the other engines on the division. The engine was afterwards sent to the Montana Division. In a paper read before the Northwest Railway Club the following remarks were made by Mr. Van Alystne, referring to the first engine noted above:

> What seems to me an especially good feature of the combustion chamber, if it is practical, is the fact that it very materially increases the heating surface of the firebox. The beauty of the combustion chamber is in getting the flues away from the fire. The great convenience and economy that is derived from this combustion chamber is due to the fact that the flues can be worked without disturbing the brick arch.

The first engine to be fitted with a combustion-chamber boiler was a four-cylinder tandem compound engine of the Mikado or 4-6-2 type, built in 1904. A comparison of the heating surface and weight of this engine with that of identical engines without the combustion chamber are given by Mr. Van Alstyne, as follows:

	With combustion chamber sq. ft.	Without combustion chamber sq. ft.
Heating Surface: Tubes	3,231.0	3,818.0
Firebox	188.5	200.0
Arch tubes	10.0	10.0
Combus. chamber	62.5	.....
Total	3,492.0	4,028.0
Grate area	43.5	43.5
Weight on drivers	207,000 lbs.	207,000 lbs.
Weight of engine	268,000 lbs.	271,000 lbs.

The 70 new engines having combustion-chamber boilers include 20 of the Pacific type (4-6-2), 30 of the Mikado type (2-8-2), and 20 of the Prairie type (2-6-2). All these have been built by the American Locomotive Co., of New York; those of the first type at its shops at Schenectady, N. Y., and those of the other two types at its Brooks shops at Dunkirk, N. Y. For particulars and drawings of these engines we are indebted to the builders.

PACIFIC TYPE (4-6-2).—The 20 engines with combustion-chamber boilers which have recently been completed are identical with a number of others built by the company for the same railway, with the exception of the boiler design. The boilers in both cases are of the extended wagon-top pattern, of the same outside diameter at front and back, and with the same length over all. They have radial-stay fireboxes of the same size. Both boilers have 2-in. tubes, and these are spaced 2⅜-ins. c. to c. at the front end in the boiler with combustion chamber and $2^{29}/_{32}$ ins. in the other boilers. In the first case there is a combustion chamber 3 ft. long and the tubes are 16 ft. 9 ins. long. In the engines without combustion chambers the tubes are 18 ft. 0 ins. long; or, in other words, the combustion chamber cuts off 1 ft. 9 ins. from the length of the tubes. In addition to being shorter, the tubes are also less in number, there being 306 tubes in these boilers as against 347 in the boilers without combustion chambers. The tube heating surface and total heating surface are, accordingly, much less in the former engines than in those without combustion chambers, while the firebox heating surface is much greater. The comparative heating surfaces are given on the following page, and from this comparison it will be seen that the tube heating surface has been reduced 602 sq. ft., or 18%; and the total heating surface, 550 sq. ft., or about 15.6%; the firebox heating surface has been increased 51 sq. ft., or about 28%.

	With combustion chamber.	Without combustion chamber.
Heating surface:	sq. ft.	sq. ft.
Tubes	2,737	3,339
Firebox	233	182
Arch tubes	9	7
Total	2,979	3,528

It will be interesting also to compare the ratios of tube heating surface and total heating surface to the volume of one cylinder in the two classes of engines, both having the same size cylinders. The tube heating surface divided by the volume of one cylinder is 478 and 583 in the engines with and without combustion chambers, respectively, the total heating surface divided by the volume of one cylinder is 520 in the former and 616 in the latter. These ratios are lower in the engines with the combustion chamber, and higher in the engines without the chamber, than the ratios generally found in locomotives of the Pacific type, the average ratio of tube heating surface to cylinder volume in this type being about 525, and of total heating surface to cylinder volume 550. While it might appear that this great reduction in heating surface was a rather questionable experiment, particularly in this type of engine in which large boiler capacity is essential, this design of boiler is no new experiment on the Northern Pacific Ry., as already noted.

The combustion chamber in the Pacific type engines is supported by expansion stays, radial stays, staybolts and bottom braces or gusset plates. The water space is 7½ ins. at the bottom and 7 ins. at the sides, giving good water circulation with no danger of the combustion chamber being overheated. In these engines the front tube sheet was moved 15 ins. further ahead than it is in the Pacific engines without combustion chambers. This was done to avoid reducing the length of the tubes by the full length of the combustion chamber, as the number of tubes had also been reduced. Though the tube heating surface is greatly reduced by the combustion chamber, the firebox heating surface is greatly increased, and in the case of the Mikado type (above referred to) this increase in the firebox heating surface seems to more than offset the loss of the tube heating surface and to give an engine with equally good steaming qualities.

These new engines afford a good opportunity for judging of the comparative merits of the two designs of boiler; and the record of these engines with combustion chambers as compared with those of the same design but having boilers without combustion chambers running on the same road and under the same conditions will be of great interest. Further interest will be added from the fact that one engine is equipped with the latest design of the Schenectady superheater. Thus there will be an opportunity to watch and compare the performance of the three different features in recent locomotive construction: (1) the simple engine with long tubes; (2) the simple engine with short tubes; and (3) the simple engine with combustion chamber and superheater. All three engines are identical in design except for the special features of combustion chamber and superheater.

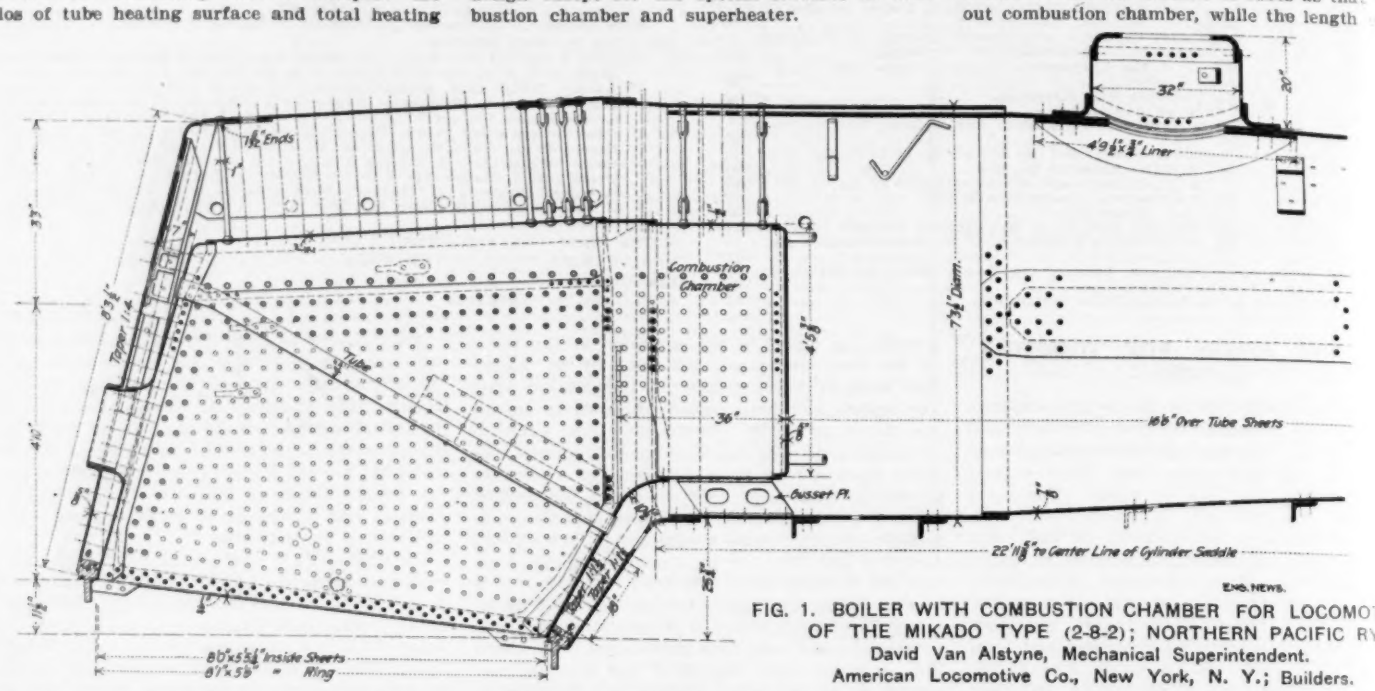
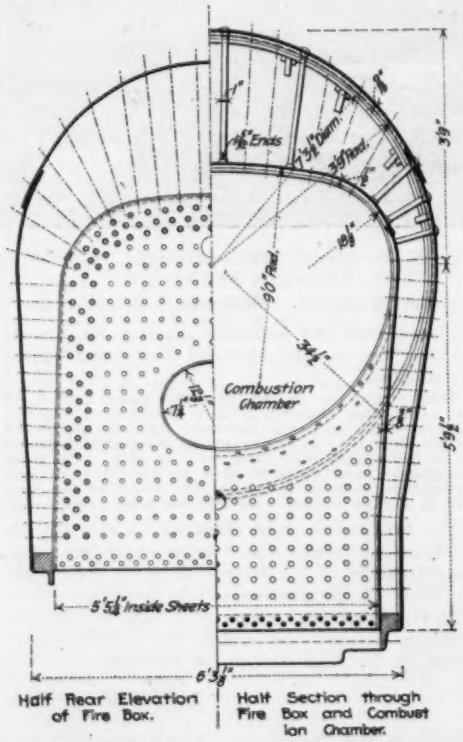


FIG. 1. BOILER WITH COMBUSTION CHAMBER FOR LOCOMOTIVES OF THE MIKADO TYPE (2-8-2); NORTHERN PACIFIC RY.
David Van Alstyne, Mechanical Superintendent.
American Locomotive Co., New York, N. Y.; Builders.

The leading dimensions of these engines are given in the accompanying table, but some special particulars of the one Pacific engine fitted with the superheater which differs from those of the other engines are as follows:

Weight on drivers	147,500	lbs.
Weight, engine	226,500	"
Weight, eng. and tender	368,300	"
Tubes, No.	192	
Superheater tubes; diameter, 5 ins.; No.	24	
Heating surface, tubes	2,196.4	sq. ft.
" firebox	233.4	"
" arch tubes	8.9	"
Total	2,438.7	"
Superheating surface	341.15	"



MIKADO TYPE (2-8-2).—The 30 new engines of this type are identical in design with simple engines built for the Northern Pacific Ry. in 1904 and 1905 except for the special feature of the combustion chamber. They are also identical with the first engine to have a combustion chamber, except that they are simple, while the latter was a four-cylinder tandem compound. In the Mikado type engines, however (as is not the case in the Pacific type engines above described), the boiler with combustion chamber contains the same number of tubes as that without combustion chamber, while the length of the tubes has been shortened by the full length of the combustion chamber. This reduces the total heating surface by 14.2%. The comparative heating surfaces of the two classes of the Mikado type are as follows:

	With combustion chamber.	Without combustion chamber.
Heating Surface.	sq. ft.	sq. ft.
Tubes	3,192	3,798
Firebox	234	200
Arch tubes	11	9
Totals	3,437	4,007

The general features of the boiler design are shown in Figs. 1 and 2; these represent the

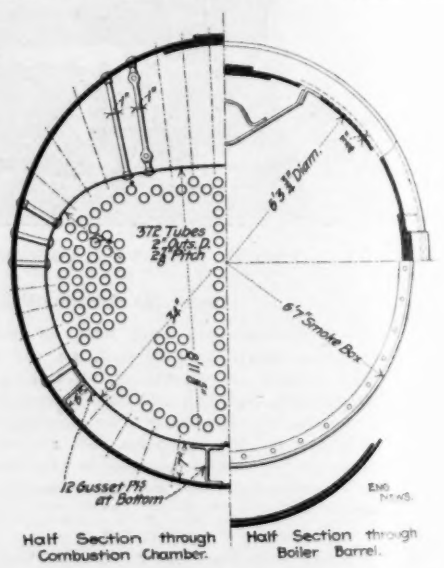

372 Tubes 2" Outs. @ 2 3/8 Pitch
6'3 1/2" Diam.
6'7" Smoke Box
12 Gusset Pls. at Bottom
ENG. NEWS.
Half Section through Combustion Chamber.
Half Section through Boiler Barrel.

FIG. 2. CROSS SECTIONS OF BOILER WITH COMBUSTION CHAMBER; NORTHERN PACIFIC RY.

boilers of the Mikado (2-8-2) engines, but those of the other engines are very similar except in matters of detail. The firebox has sides almost straight and a very flat crown sheet, but in the engines of the 4-6-2 and 2-6-2 types the sides are quite straight or flat, flaring slightly from the crown sheet to the mud ring. The combus-

tion chamber is supported by radial stays and staybolts, while on each side and at the bottom are gusset plate connections between the chamber and the boiler shell.

PRAIRIE TYPE (2-6-2).—These engines are the first of this type to be built for the Northern Pacific Ry., but the type has proved so satisfactory on other roads that 20 were ordered; these were completed in May. All these engines are equipped with boilers having combustion chambers. The combustion chamber in th engines of this type is 4 ins. shorter than in the other two types described, and the tubes are some 3 ft. shorter. These differences, however, are due solely to differences in the types of the engines.

One engine of both the Mikado and Prairie types is equipped with the Walschaert valve gear. The Prairie type engine, having both the combustion-chamber boiler and the Walschaert valve gear, is shown on page 531. In this engine the combustion chamber is 2 ft. 8 ins. long. The other principal dimensions are as follows:

Driving wheels	5 ft. 3 ins.
Wheelbase, driving	11 ft. 0 ins.
Wheelbase, engine	28 ft. 11 ins.
Cylinders	21 × 28 ins.
Boiler, diameter	6 ft. 2¼ ins.
Firebox	8 ft. 0 ins. × 5 ft. 5¼ ins.
Tubes, No. 306, diameter	2 ins.
Tubes, length	13 ft. 3 ins.

The accompanying table gives the principal dimensions of the engines of the Pacific (4-6-2) and Mikado (2-8-2) types.

Locomotives with Combustion Chambers:	Pacific Ry.	Northern Pacific Ry.
Type	4-6-2	2-8-2
Driving wheels	5 ft. 9 ins.	5 ft. 3 ins.
Wheelbase, driving	12 ft. 0 ins.	16 ft. 6 ins.
Engine	32 ft. 6 ins.	34 ft. 9 ins.
Engine and tender	61 ft. 11 ins.	65 ft. 11¼ ins.
Weight, on drivers	146,300 lbs.	199,000 lbs.
Engine	223,000 lbs.	256,500 lbs.
Engine and tender	364,800 lbs.	434,300 lbs.
Cylinders	22 × 26 ins.	24 × 30 ins.
Valves, piston		
Travel	6 ins.	5⅝ ins.
Steam lap	1 in.	1 in.
Exhaust clearance	¼ in.	0 in.
Boiler, type	Ext. wag-top	Ext. wag-top
Boiler, diameter at first ring	6 ft. 0½ ins.	6 ft. 3⅝ ins.
Steam pressure	200 lbs.	200 lbs.
Firebox	8′ × 5′ 5¼″	8′ × 5′ 5¼″
Tubes, No.	306	372
Diameter	2 ins.	2 ins.
Length	16 ft. 1 in.	16 ft. 6 ins.
Combustion chamber, length	3 ft. 0½ ins.	3 ft. 0 in.
Heating surface, tubes	2,736.7 sq. ft.	3,192 sq. ft.
Firebox	232.8 sq. ft.	234 sq. ft.
Arch tubes	8.9 sq. ft.	11 sq. ft.
Totals	2,978.4 sq. ft.	3,437 sq. ft.
Grate area	43.5 sq. ft.	43.5 sq. ft.
Water in tender	7,000 gals.	10,000 gals.
Coal in tender	12 tons	12 tons
Tractive power	31,000 lbs.	46,630 lbs.

OTHER COMBUSTION-CHAMBER BOILERS.

As already noted, the use of combustion chambers in locomotive boilers dates back some 50 years or more, and has had its most extensive development in the Wootten type of boiler with its enormously wide and long but shallow firebox specially designed for burning the refuse or small unmarketable sizes of anthracite coal. This boiler was designed by Mr. Wootten, of the Philadelphia & Reading Ry., in 1877. Figs. 3 and 4 show a boiler of this type built in 1904 for a consolidation (2-8-0) engine for the Lehigh Coal & Navigation Co.; the combustion chamber is larger than in the engines of the Northern Pacific Ry. above described, while the 2-in. tubes are shorter and the heating surface is less. The boiler is of the straight-top type, and has the dome placed close to the smokebox tube sheet. The general dimensions of this engine are as follows:

Driving wheels	4 ft. 8 ins.
Weight on drivers	175,810 lbs.
Weight of engine	194,110 lbs.
Cylinders	22 × 28 ins.

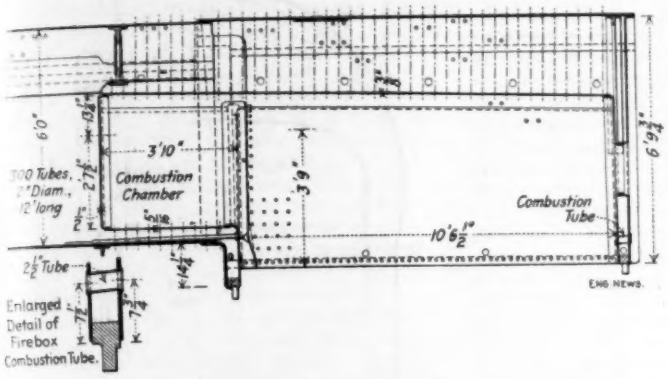


FIG. 3. WOOTTEN BOILER WITH COMBUSTION CHAMBER; LEHIGH COAL & NAVIGATION CO.
Baldwin Locomotive Works, Philadelphia, Pa.; Builders.

Boiler, diameter	6 ft. 0 ins.
Tubes, 300, length	12 ft. 0½ ins.
Firebox, length and width	10½ × 9 ft.
Firebox, depth	4 ft. 7 ins. to 4 ft. 10 ins.
Combustion chamber, length	3 ft. 10 ins.
Heating surface, tubes	1,880 sq. ft.
" " firebox	188 sq. ft.
" " combus. cham.	65 sq. ft.
" " total	2,133 sq. ft.
Grate area	95 sq. ft.

In the original design of the Wootten boiler there was a seam at the junction of the chamber with the firebox, but when the Baldwin Locomotive Works undertook their manufacture several improvements were made, among these being the use of a single plate for the firebox crown sheet and combustion chamber roof sheet. In the early days of this boiler, however, Mr. Alexander Mitchell, of the Lehigh Valley Ry., contended that the combustion chamber was unnecessary, and some engines were built for him having a Wootten firebox with a plain, straight tube sheet for the front end. According to statements by Mr. Samuel Vauclain, of the Baldwin Locomotive Works, this tube sheet arrangement gave much more trouble than the combustion chamber, owing no doubt to the great amount of cold air which at times came through the shallow fire and passed over the ends of and through the tubes.

Many attempts were made to remedy this defect, and the result was the placing of the tube sheet about 6 ins. ahead of the throat sheet, forming what was termed a D-head. This prevented the cold air from striking the ends of the tubes and causing leaks, while it also prevented these from coming in direct contact with the fire. Fig. 5 shows a section and elevation of this arrangement as applied to 95-ton consolidation (2-8-0) locomotives with Wootten fireboxes recently built for the Delaware, Lackawanna & Western Ry. by the Rogers Locomotive Works, of Paterson, N. J. These engines have driving wheels 4 ft. 9 ins. diameter, and cylinders 21 × 26 ins., while the boilers carry a working steam pressure of 200 lbs. It will be seen that the tube sheet proper is a flanged plate riveted to the crown sheet and to another flanged plate forming the lower part of the front of the firebox; this arrangement sets the tube sheet about 5 ins. forward of the firebox proper. Several other types of engines for this road have the same arrangement. At the present time, however, many boilers of the Wootten type are built without either the combustion chamber or the D-head.

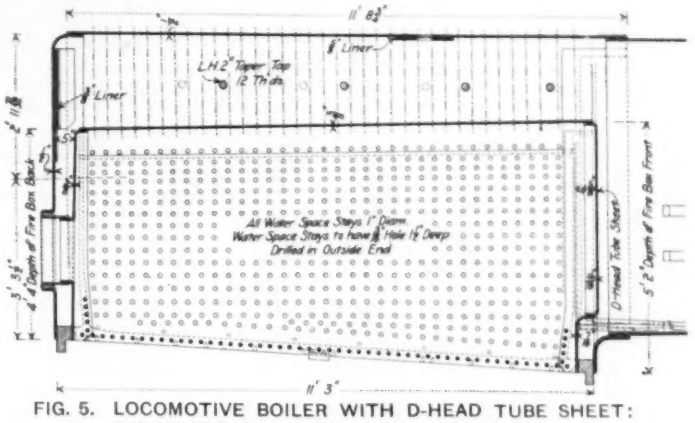

11' 8½"
8" Liner
LH 2" Taper Top 12 Thds.
4" Liner
All Water Space Stays 1" Diam. Water Space Stays to have ⅛" Hole ½" Deep Drilled in Outside End
D-Head Tube Sheet
11' 3"

FIG. 5. LOCOMOTIVE BOILER WITH D-HEAD TUBE SHEET: DELAWARE, LACKAWANNA & WESTERN RY.
Rogers Locomotive Works, Paterson, N. J.; Builders.

Both the D-head and the combustion chamber have in some cases been applied to deep fireboxes. An example of the first case is a Baldwin mogul (2-6-0) engine built in 1904 for the Cardenas & Jucaro Ry., of Cuba. This had a radial-stay firebox 6 ft. long, of "mushroom" section, 83 ins. deep, and with a width of 2 ft. 9 ins. between the frames, or a height of 3 ft. 6 ins. above the mud ring. The flanged tube sheet and flanged front plate gave a total offset of 5 ins. An example of the second case is a Baldwin engine built in 1905 for the Western Ry. of Guatemala (3-ft. gage), and designed to burn wood or coal. This is shown in Figs. 6 and 7. The firebox is 3 ft. 9¼ ins. long, 4 ft. wide at the grate and 3 ft. 7 ins. at the top, with a depth of 4 ft. 10½ ins. The combustion chamber is 1 ft. 8⅝ ins. long, and 2 ft. 9 ins. deep from the crown sheet, having 20 sq. ft. of heating surface.

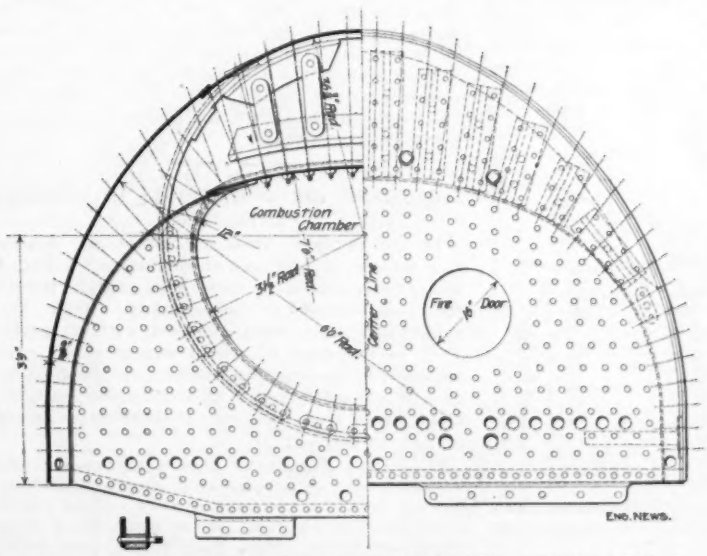


FIG. 4. CROSS SECTION OF WOOTTEN BOILER; LEHIGH COAL & NAVIGATION CO.

It may be noted that a combustion chamber arrangement very similar to that of the Northern Pacific Ry. was used in some ten-wheel passenger engines on the Mediterranean Ry., of Italy, in 1890.

COMBUSTION CHAMBERS FOR CYLINDRICAL FIREBOXES.—In locomotives having cylindrical fireboxes or internal furnace flues, the combustion chamber principle has been very generally adopted. In the original Strong loco-

motive boiler having two corrugated furnaces, the furnaces were united by a Y-piece or breeching, with a combustion chamber, at the end of which was the tube sheet (Engineering News, April 6, 1889, and Aug. 19, 1897). We believe that only one engine of this type was built. In the Vanderbilt boiler, with a single large corrugated furnace, a combustion chamber was formed by a bridge wall at the end of the grates, this wall being about about 30 ins. from the

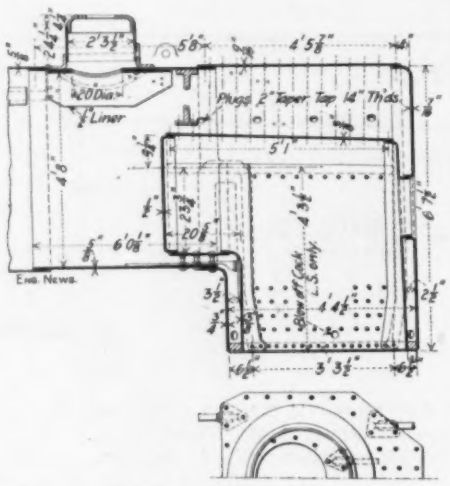


Fig. 6. Deep Firebox with Combustion Chamber: Western Ry. of Guatemala. Baldwin Locomotive Works, Philadelphia, Pa.; Builders.

tube sheet (Engineering News, Aug. 24, 1899). On a number of European railways the combustion chamber has been tried. The Lentz boiler at one time used in Germany had a single furnace flue, about one-third of which was shut off from the firebox proper by a firebrick wall pierced with openings. Air was blown through jets in the walls of these openings to ensure a complete combustion of the gases in the combustion chamber.

INDEPENDENT COMBUSTION CHAMBERS.—In all the boilers so far mentioned, the combustion chamber is an integral part of the firebox, although in some cases partitioned off by a bridge wall or brick arch. A radically different arrangement, however, was introduced in 1891 by Mr. F. W. Webb, then Superintendent of Motive Power of the London & Northwestern Ry., of England. The combustion chamber was a separate box, 2 ft. 8½ ins. long, placed in the boiler barrel and connected with the firebox by 156 tubes 2⅛ ins. diameter and 5 ft. 10 ins. long. The 156 tubes to the smokebox were 2½

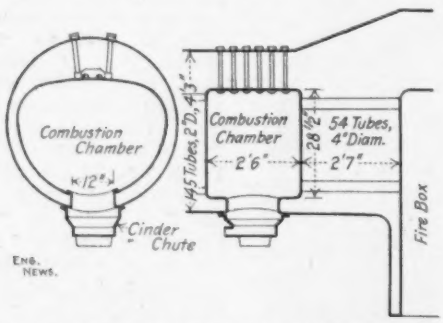


Fig. 8. Locomotive Boiler with Independent Combustion Chamber; Chicago, Burlington & Quincy Ry.

ins. diameter and 10 ft. 1 in. long. The boiler was 4 ft. 3 ins. diameter. This arrangement was first tried on a 52-ton three-cylinder compound passenger engine of the 2-4-2 class, having driving wheels 7 ft. 1 in. diameter; it had two high-pressure cylinders 15 × 24 ins., and a single low-pressure cylinder 30 × 24 ins. This boiler was not a success.

The same arrangement was tried in 1892 on the Chicago, Burlington & Quincy Ry., but the tubes between the firebox and combustion chamber (2 ft. 7 ins. long) were made 4 ins. in diameter, while the other tubes were 2 ins. in diameter. The combustion chamber was placed in the circular barrel, just ahead of the wagon top. It was of approximately oval section, 2 ft. 6 ins. long and 2 ft. 9 ins. high; the top sheet was only slightly curved, while the sides and bottom were concentric with the boiler shell. An ash hopper extended from the chamber through the shell. This arrangement is shown in Fig. 8. The boiler was designed by Mr. F. Higginson, and was built in 1892, being applied to an engine employed in suburban service. We are indebted to Mr. F. H. Clark, General Superintendent of Motive Power, for an opportunity to examine the records of the performance of this engine. When sent out with a five-car train and intended to return with a heavy train it was often necessary to attach it simply to a three-car train for the return trip, as the combustion chamber would be full of cinders, while the 2-in. tubes from this chamber to the smokebox would be leaking. The engine was finally assigned to a regular run with a three-car train, but even then it was a difficult matter to keep it in service. Every few days it had to be taken to the shop to have the manhole taken off and the combustion chamber cleaned out; at the same time about one-third of the 2-in. tubes would be stopped up with cinders. The 4-in. tubes from the firebox to the combustion chamber also gave considerable trouble, as they were leaking most of the time and did not seem to have sufficient provision for expansion. The engine had 17-in. cylinders, and the exhaust nozzle had to be bushed down to 3¼ ins. diameter in an endeavor to create a sufficiently strong draft to draw the cinders through the small tubes so that the engine would make steam.

No work could be done on the combustion chamber ends of the tubes without cooling the engine down, and whenever the tubes had to be calked the engine was laid up in the shop for a day or two to enable the work to be done, so that it was out of service for a large proportion of the time. When the engine was sent to the Galesburg shops in December, 1894, the beads were worn off all the tubes owing to the continual working upon them. The boiler proved to be an entire failure, and the engine would burn more coal and use more water than any other similar engine in the suburban service. Different enginemen were assigned to the engine, but the results were always the same. The tubes could not be kept tight, and the engine could not be made to steam even when the tubes did not leak, while it spent too much time in the roundhouse for repairs when it was needed on the road. In June, 1895, the combustion chamber boiler was removed.

SUGGESTIONS FOR CONTRIBUTORS TO TECHNICAL LITERATURE.

In the October "Proceedings" of the American Society of Mechanical Engineers we find a set of suggestions to those who prepare papers for presentation to the Society. While the suggestions have been prepared with a special view to the form in which papers to be read before that society are desired, the suggestions as a whole will interest all writers for the technical press and we present them here nearly in full as follows:

In preparing a paper for presentation before a professional society or for publication there are some general principles, the observance of which will add greatly to the value of the work. In the first place, a paper should, and generally does, relate to some especial department of work with which the author has had experience, so that he is very apt to assume many things as matters of common knowledge, when in fact they are not nearly so familiar to most of the audience as they are to himself. It is not usually a mistake to be too clear, particularly in the preliminary statements.

State first, in a brief and clear manner, just what the paper is about, what the author is endeavoring to show, or what he expects to prove. This introductory statement should be very brief, and having been made it should be kept in mind throughout. A paper should be about but one thing at a time, and that one thing plainly stated at the start.

Then should follow the general treatment; description of work, of experiments, of opinion, etc., this portion constituting the matter usually forming the body of technical articles or papers.

After this should come a statement showing how the general matter immediately preceding has demonstrated what the author set out to show.

Finally there should come a very condensed summing up, in such a form that a brief glance would enable

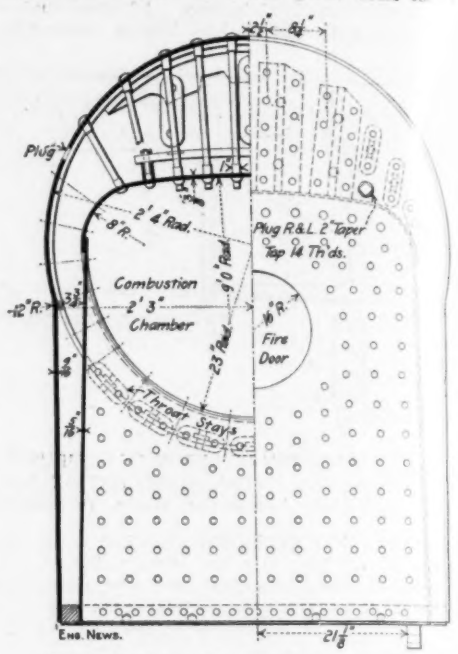


Fig. 7. Firebox with Combustion Chamber.

a casual reader to grasp the substance of the paper, and decide, without reading the whole, whether or not he wants to examine it in detail.

The use of tables should be avoided whenever it is practicable to present results in a summarized form and where the tables do not make in themselves a distinct addition to the value of the paper.

Papers may be divided into two classes: those which give a record of experience or investigation in a formal manner, presented mainly for the purpose of putting the subject upon the official record; and those intended to arouse discussion, and presented for the very purpose of eliciting the opinions and experience of members at the meeting.

The purpose of the second of these classes cannot be successfully attained unless the original paper is in a form which permits the argument to be readily grasped. Many members do not have the opportunity of examining the paper until a few minutes before it is presented and yet these should be able by a glance at the introduction and the conclusion, to decide whether it is a subject which they can discuss. Results of investigations are sometimes given in final form only, as tables or plotted curves, and while these are both most desirable, there should always be a general summing up of the leading results of importance in plain language, for immediate absorption by any one.

Write plainly on one side of the paper. Number the sheets consecutively in the upper right hand corner and have them of a uniform size. A good size is 8½ × 11. It is desirable to have manuscript typewritten when this can be done without undue inconvenience. Put your full name and address on all manuscripts. Never fold illustrations intended for reproduction. Tracings may be sent rolled in mailing tubes.

All diagrams, drawings, etc., should be made on separate sheets of paper.

In making drawings intended for reproduction it is well to exaggerate the size of all numerals and dimensions so that under reproduction on a reduced scale they will still be legible. The greater the reduction the heavier should be the lines to give sharp results. Do not use red ink, as it does not reproduce.

In selecting photographs or making photographic prints for illustrations, it should be remembered that the glossy solio prints are better suited for reproduction than velox, or other matte surface paper, besides bringing out all the detail in the negative to the best advantage. Photographs should not be printed too deep, and the reproductions are better made from prints of a slightly reddish tone than from those over-toned to a bluish tint.

All copy intended for illustrations should be clearly marked with the title, subject and author's name, a reference to the manuscript to which it relates, and all other data of interest. This had better be written on the back in pencil; ink is apt to show through, espe-

ideally when written on the back of light portions of a photograph.

The places where plate and figure references are to be inserted in the text should be indicated in the manuscript. Illustrations should only be used where necessary for the elucidation of the text—never for mere embellishment. A list of illustrations giving their titles in brief should accompany the manuscript.

A RAPID CURRENT HOT WATER HEATING SYSTEM.

A rapid-current heating system has the advantage that small pipe may be used with consequent lower cost in constructing the pipe circuits as compared with ordinary warm-water heating systems or with low pressure steam heating systems. On the other hand, if the same size of piping is used, the more rapid circulation enables the use of smaller radiators.

A rapid-current heating system has come into extensive use in Germany and England recently, and is known as the Brückner system, after its inventor.* The rapid circulation of the water is produced by a short length of pipe in which steam separation and emulsion take place.

Referring to Fig. 1, K represents the boiler, R the regulator, A a closed expansion tank, A' an open safety tank, V the condenser, and F the draft regulator. The boiler is in direct communication with the safety tank A' through the return pipe No. 4, so that the system is of the open warm-water type.

When the temperature of the water leaving the boiler rises above the boiling point, vaporization begins in pipe No. 1 and steam bubbles are formed in the rising pipe. The flow to the expansion tank A is composed of a mixture of water and steam, the specific gravity of which is much less than that of water alone.

In the expansion tank A, the steam bubbles rise to the surface of the water, and the pressure from below forces them through the pipe at the top of the expansion tank to the condenser, while the heated water, containing no steam, finds its way to the radiators through pipe No. 2.

Disregarding the difference in specific gravity between the water columns in pipes 1 and 4, and 2 and 3, it follows that the circulation power, or motive force, obtained depends entirely upon how much the total weight has been reduced by the length of the column of mixed steam and water, i. e., by the specific gravity of the emulsion column a, if we assume that separation begins, under normal conditions, near the lower edge of the regulator and that the rising pipe enters the expansion tank A just above its bottom.

Let us suppose that the water flowing upward through the rising pipe has been heated to such a degree that separation begins only near the upper edge of the regulator. In that case, that part of the rising pipe a-1 or a' will be filled with steam bubbles, the pressure on the separation or vaporization zone will be immediately diminished, and as a natural consequence it will immediately fall downward until it reaches its lowest normal permanent position, which we may assume to be somewhere about the lower edge of the regulator.

The amount of the steam vaporized will be determined, first, by the difference in temperature of the water at the lowest point of the rising pipe, where it leaves the boiler, and at its highest point; second, by the hydrostatic pressure exerted at these points; and third, by the amount of water flowing through the pipes, because these factors give the number of calories or heat units available for vaporization and determine the volume of the steam.

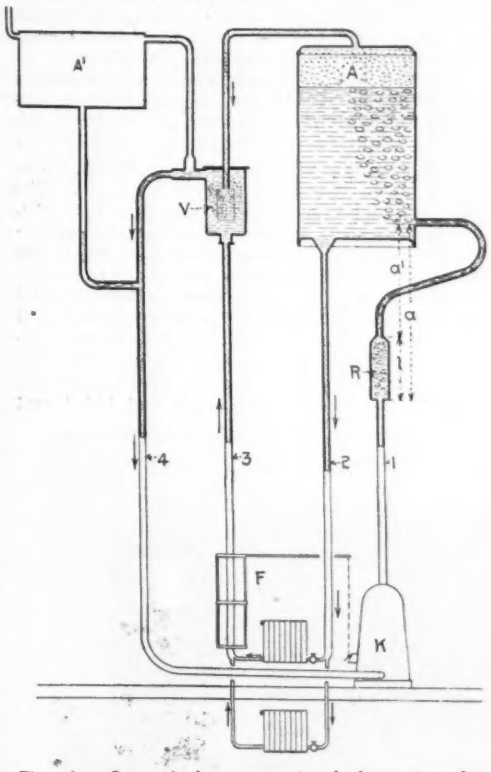


Fig. 1. General Arrangement of Apparatus for Creating a Rapid Circulation of Hot Water Through the Pipes of a Heating System.

On the other hand, the constant increase of steam separation in the rising pipe and its consequent expansion, cause a great acceleration in velocity in the same sectional pipe area; this gives rise to a certain amount of back pressure which tends to counteract the steam separation.

In this way automatic regulation is obtained, for whenever the mixing of steam and water becomes too great, causing too rapid circulation of water in the rising pipe, the back pressure increases and immediately reduces the process of steam formation.

In the Brückner system with apparatus of average dimensions and with moderate circulating heights, it is claimed that only about two-fifths of the sectional pipe area is required compared with a low-pressure steam heating system of the same capacity.

Noise which might result from too great a velocity of water is prevented in the Brückner system. Care must also be taken when constructing the installation to prevent the emulsion from running off too quickly; for this purpose it may be found necessary to increase the water capacity, particularly the boiler capacity, or to create a back pressure by placing rising pipes of carefully chosen sectional areas between the regulator R and reservoir A.

The water flows into the radiators, as a rule, at a temperature of about 99° C., and as the water should always enter and leave the radiators from below whenever possible, the average normal temperature of the water in all the radiators will be about 85° C.

The second expansion tank A', Fig. 1, is simply a safety tank for equalizing the pneumatic pressure produced by firing, and for the purpose of receiving an extra flow of water caused by too hot a fire. Automatic central regulation can be obtained to a certain extent. The draft regulator is set in action by the fall in temperature of the water. The water can show temperature differences of about 30° C., so that a general reduction in the heat production of about 20% can be brought about.

If the radiators are placed lower than the boiler, as in Fig. 2, circulation through them will only take place if the current is rapid. If the radiators are placed higher than the boiler, as in Fig. 3, so that a natural circulation is induced by the influence of difference in specific gravity, the system can be worked within certain limits as an ordinary warm-water system.

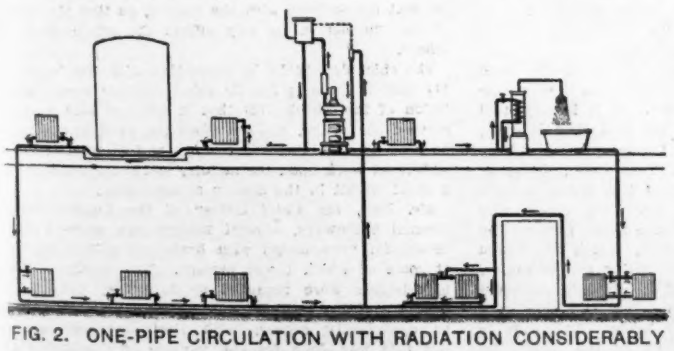


FIG. 2. ONE-PIPE CIRCULATION WITH RADIATION CONSIDERABLY BELOW THE BOILER.

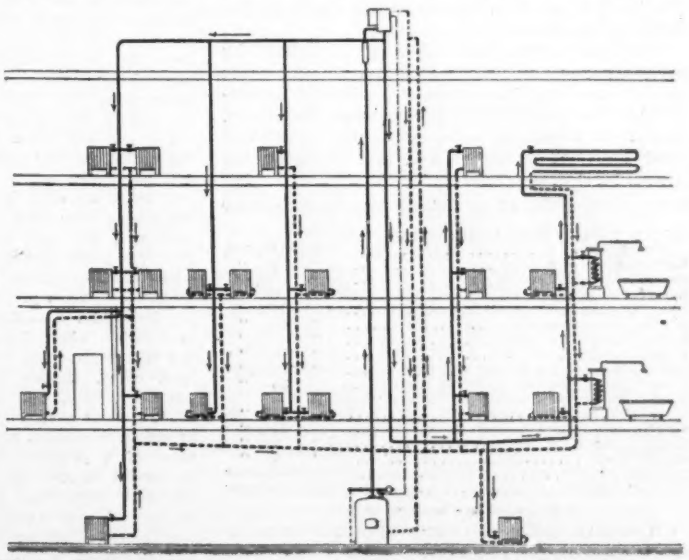


FIG. 3. TWO-PIPE CIRCULATION AND RADIATION ON BOILER LEVEL.

*Arthur J. Herschmann, 25 Broad St., New York, is sole representative of this system in the United States.

AN ELECTRIC MOTOR-DRIVEN PUMP FOR FIRE

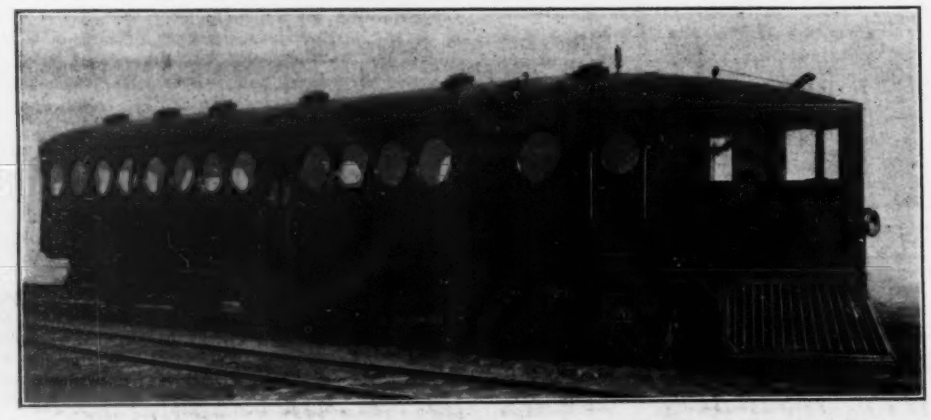
Protection recently installed in one of the large warehouses in Chicago presents some novel features as regards the construction of the motor. To insure continuous operation of the motor in case it becomes submerged in water and debris during a fire, the motor is completely enclosed and the joints in the protecting end plates are ground to make them water-tight. At the commutator end of the machine the motor casing is provided with three hand holes, each fitted with two glass ports for observing the operation of the machine, while the connection between motor and pump, at the opposite end of the motor, is made through a stuffing box. Since the protective device renders the motor air-tight, special arrangements are made for ventilation. Air is drawn into the motor casing from outside the building by a fan on the armature sraft. The inlet opening is at the commutator end of the machine, and the outlet pipe is at the back of the motor; the latter has a special involute form in order to establish a steady flow of air through all parts of the motor by keeping the air in motion in the exhaust pipe. With tight piping connections to the outer air, the motor and pump are claimed to be perfectly water-tight and to operate when entirely submerged. The motor capacity is 180 HP. It has six poles, and on 220 volts direct-current runs at 800 r. p. m. The pump, which is direct-connected to the motor, is of the 6-in., four-stage centrifugal type, and has a capacity of 1,000 gals. per min. against a cressure of 150 lbs. pe rsq. in. Information regarding this equipment was supplied us by the General Electric Co., Schenectady, N. Y., who installed the set.

A NEW GASOLINE MOTOR CAR FOR THE UNION PACIFIC RAILWAY.

The gasoline motor car shown in the accompanying illustration is the eighth one built for the Union Pacific Ry. Several of these cars have already been described in our columns.* The present one differs from those previously shown, in being provided with central vestibules and oval windows.

The side door entrances add materially to the comfort of the passengers without in any way weakening the car frame. The steps being inclosed by the side doors, no trouble is expected from the accumulation of ice and snow in winter. The advantage gained by the round or oval windows is in the increased strength of the car frame. Rubber gasket seats are fitted to the windows to make them water, wind and dust proof.

Very few changes have been made in the transmission gear on the front trucks from that used on the previous cars. The engine develops 200 HP., and was built in the company's Omaha shop. It is of special design, and has 10 × 12-in. cylinders with jump spark ignition. A remarkable advantage gained in this engine is that the



230-HP. GASOLINE MOTOR CAR RECENTLY COMPLETED FOR THE UNION PACIFIC RY.

car speed is almost entirely controlled by the throttle, the same as in a steam locomotive.

The speed can be varied from 3 to 70 miles per hour, even on grades, by means of the throttle and spark levers only. The engine is direct connected to the axle, although it is preferable to use the gears in putting the car in motion. After the car is started, the gears are thrown out and the speed of the car is controlled entirely by the speed of the engine.

The car weighs 61,300 lbs. It is lighted by acetylene gas and heated by hot water from the engine jackets. An air-brake equipment is provided. The inside finish is of Cuban mahogany, and there is seating capacity for 75. The principal dimensions of the car are given in the annexed table.

Table of Dimensions of the Union Pacific Gasolene Motor Car.

Length from pulling face of coupler to front of pilot	56 ft.	11½ ins.
Length over end sill	55 "	2 "
Extreme length inside	54 "	6⅝ "
Length, engine room	12 "	8 "
Length, passenger compartment	41 "	10⅝ "
Width over sheathing	9 "	8¼ "
Width over side sills	9 "	8 1/32 "
Width inside	9 "	5¼ "
Height, top of rail to top of roof	12 "	1 3/16 "
Height, top of rail to center of coupler		35 "
Height, top of rail to top of bottom step-tread		19¼ "
Height, top of rail to bottom of side sill		41½ "
Height, inside of car	7 "	8¼ "
Wheel base	29 "	4 "
Driving wheel	42 ins.	diameter
Trailing wheels	33 ins.	diameter

A GENERAL ADVANCE IN PRICES OF ELECTRICAL materials and supplies is announced by the General Electric Co., which states that orders for future delivery can now only be placed in many instances at a considerable advance over present market rates. The continued high prices of all classes of raw materials, particularly copper, is the chief ground for the advance in prices, and it is stated that still further advance in prices may be made if present market conditions continue.

*Engineering News, April 6, 1905, p. 355; Dec. 21, 1905, p. 653; May 17, 1906, p. 533.

A BOARD OF TRADE REPORT ON AN ENGLISH RAILWAY ACCIDENT: BRAKES FOR ELECTRIC CARS ON STEEP GRADES.

In an editorial note in our last issue we called attention to the official investigation of railway accidents which is made in great Britain by an expert engineer under direction of the Board of Trade, a department of the British Government exercising functions not unlike those used by our own Department of Commerce and Labor.

In order that our readers may see something of the maner in which these investigations are made and the reports on them are rendered, we reprint below nearly in full a recent report on a runaway of an electric car on a grade which occurred on June 23 last near Highgate. The report is dated Aug. 31, and is signed by Col. H. A. Yorke. It opens by detailing the circumstances of the accident, which may be briefly summarized as follows: A trolley car ran away down a grade of between 4 and 5% (1 in 22 and 1 in 23). The motorman became frightened and jumped off. The car collided with several vehicles and finally ran into a standing car at the terminus. In its run down the grade three persons in the street were struck and killed and about 20 were injured. The passengers in the car escaped with few injuries. We quote further from Col. Yorke's report as follows:

The car, which has a seating capacity of 68, viz., 30 inside and 38 outside, was a double deck bogie car, with eight chilled cast-iron wheels and maximum traction trucks (small wheels leading). There was a 35-HP. motor on each bogie truck, the motors being geared with the axles of the large or driving wheels. It weighed twelve tons when unloaded, and I was informed by the engineer of the company that he estimated about four tons were carried upon each of the driving axles, and two tons upon each of the pony axles, from which it appears that only about 66% of the total weight of the car was carried on the driving wheels.

The car was fitted with hand brakes of the usual description working brake blocks on all the eight wheels, and also with electro-magnetic track brakes, having two shoes on each bogie, or four shoes in all; and there were four sand boxes and pipes, namely two at each end, the sand being distributed in the ordinary way by a pedal worked by the motorman.

The electro-magnetic track brake is one of the most modern and, when properly used, one of the most effective devices for controlling tramcars. It is largely used in America, where I saw it for the first time in 1902, and it has also been adopted in several places in England, e. g., London (L. C. C. Tramways), Glasgow, Lancaster, Bath, &c. Each shoe of this brake consists of two narrow steel plates 15 ins. long, placed side by side with a small interval between them, forming the poles of a powerful electro-magnet, which is excited by current supplied by the motors acting as generators. The shoe when thus magnetized is strongly attracted to the rail over which it is suspended, and acts as a very powerful slipper (or track) brake. The shoe is also connected to the brake blocks on the wheels by a system of levers in such a way that the drag on the shoe caused by its adhesion to the rail presses the blocks against the wheels, so that the magnetic brake operates as a wheel brake as well as a track brake. These brake blocks are the same as are operated by the hand brake lever. There is, however, no necessity to connect these blocks with the magnetic shoe; the latter can be used by itself as a track brake pure and simple, and be entirely independent of the wheel brakes, and it is often so arranged. Resistances are provided between the motors and the magnets which regulate the current in the latter, whereby the magnetic adhesion can be so adjusted as either to cause the car to travel at any required speed or to stop it altogether. The retarding effect of the brake is therefore due to three causes, viz., (1) the retardation of the motors themselves in acting as generators, in which respect it is similar to the ordinary electric rheostatic brake; (2) the adhesion (magnetic and frictional) between the magnet shoe and the rail, and (3) the pressure of the brake blocks on the wheels.

It was established by Galton in his well-known experiments with railway brakes (see papers read by Captain Douglas Galton, C.B., before the Institution of Mechanical Engineers, 24th October, 1878, and 24th April 1879, "On the effects of brakes upon railway trains") "that the co-efficient of friction between the brake blocks and the wheels varies inversely according to the speed, a higher proportion of brake block pressure to wheel being therefore required at high speeds, and a lower pressure for a lower speed." With the electro-magnetic brakes, the current generated by the motors, and the magnetic attraction produced thereby, varies directly as the speed, that is to say, the greater the speed, the greater the magnetic attraction between the magnetic shoe and the rail, and, consequently, the greater the pressure of the brake blocks on the wheels caused by the drag of the shoe; and the less the speed the less these effects. In this manner the pressures of the shoes on the rails, and of the blocks on the wheels, are automatically adjusted in proportion to the speed until, when the car stops and the wheels cease to revolve, the brake pressure is entirely released. In fact, if this brake is properly adjusted it would seem that theoretically it is impossible to skid the wheels with it. In practice, however, this it not found to be the case, as a too sudden and violent application of this brake may cause the wheels to skid, either in consequence of the drag upon the shoe and the consequent pressure on the brake blocks being too great, or in consequence of the internal resistances of the motors (acting as generators) stopping the rotation of the wheels.

The brake is operated from the controller by working the controller handle backwards over the notches provided for the purpose. In order to bring the magnetic brake into use, it is essential that the reversing key of the controller should point in the direction in which the car is moving, and that the wheels and motors should revolve so as to generate the necessary current. It should be clearly understood that this brake, as at present designed, is in no way dependent upon the traction current derived from the trolley wire, and, in fact, cannot be brought into operation until this current is cut off. It is actuated solely by the current generated by the motors themselves, so long as they continue to revolve. There is, however, no reason why the traction current should not be used for the purpose of energizing the magnets of the brake; and I am informed that the London County Council are experimenting with a car equipped in such a way that the brake magnets can be energized either by the current from the trolley wire, or the current supplied by the motors acting as generators. Each motor is connected to all the shoes, and the current generated by one motor is quite sufficient to energize all the magnets and bring all the magnetic brakes into operation. This being so, the skidding of one pair of the driving wheels would not render the magnetic brakes inoperative, as the motors on the other pair of wheels would, so long as they continued to revolve, supply current to work all the magnetic brakes. Moreover, each brake shoe has independent connections with the motors, so that the failure of one magnet in no way affects the efficiency of the others.

The chief drawbacks in connection with this brake are (1) that it depends for its effect entirely upon the rotation of the wheels; (2) that it will not hold a car at rest on an incline, and therefore the hand brake has to be used as soon as the car stops, and (3) that it brings additional work upon the motors, and occasionally causes a short circuit in the motors or armatures.

Mr. Fell, the Chief Officer of the London County Council Tramways, several months ago made a series of careful experiments with brakes of this description, at some of which I was present. The results of these experiments were regarded as favorable, and all the tramcars of the London County Council are being fitted, as opportunity occurs, with electro-magnetic brakes. But this was done for the purpose of facilitating the control of the cars in busy streets, and enabling higher speeds to be adopted with safety, and not on account of the steepness of any gradient, the London County Council tramways, so far as at present constructed, being free from steep hills.

Since June 4 car No. 115, the one which ran away, had been in the depot for repair and renovation. It had been repainted and revarnished, and generally overhauled; new brake blocks had been fitted to the driving wheels,

these blocks being adjusted, when off, to within 1/16 in. of the wheels. On June 22, the day before the accident, the car was taken out of the depot for a run of six miles over the tramway—not for traffic purposes, but in order to enable some tests of the overhead trolley equipment to be made. The car was, I was told, then found to be in perfect order. On June 23 the car left the Finchley depot for ordinary service at 1.45 p. m. in charge of Motorman Cone and Conductor Davies. Cone said that it was then in good condition, except that one of the sanders at the leading end of the car was not working properly, and that he reported the fact to Inspector Payne, who was on duty at the depot. Payne, however, denies this, and declares that no complaint whatever was made to him. Cone himself is vague as to which sander was defective, but his evidence indicates that (if any) it was the one on the near side of the leading end of the car. It is, however, to be remarked that in his evidence before the Coroner —(Cone gave evidence before the Coroner on June 25 and July 10, and I have had an opportunity of reading the shorthand notes of all the evidence given on those two occasions)—Cone said nothing at all about any defect in the sanding arrangement, and Time-keeper George Aldridge, who was on duty at the terminus in Archway Road, says that when Cone arrived there on his first trip (which had been safely accomplished) he asked Cone whether his sand gear was all right, and that Cone replied in the affirmative. Moreover, if anything was wrong it was Cone's duty to have had it rectified before he left the depot. These facts seem to show that Cone's statement as to there being something wrong with one of the sanders is not reliable.

On starting from the depot, Cone proceeded with his car to Tally Ho Corner, where the branch line from the depot joins the main line on the Great North Road between Whetstone and Highgate Archway. From Tally Ho Corner the car proceeded southwards to the terminus at Archway Tavern, a distance of four miles 3.9 chains, where it arrived at 2.20 p. m. On this occasion it descended Archway Hill without any difficulty, and everything appeared to be satisfactory (it was then that Time-keeper Aldridge spoke to Cone and asked him about his sanders). At 2.33 Cone started back from the Tavern to Whetstone, where he arrived at about 3 o'clock. On this journey Cone states that he had trouble with his hand brakes; that when he applied them the wheels seemed instantly to skid, and that when he released the hand brakes the wheels continued skidding and did not immediately commence to revolve, even though he applied sand to the rails. This is said to have happened near Muswell Hill Road, where the line is on a descending gradient. The car left Whetstone for the second trip to Highgate at 3.03 p. m., when the same trouble is said to have arisen with the brakes at Muswell Hill Road and at Shepherds Hill. At Muswell Hill Road the hand brake alone was tried, at Shepherds Hill the magnetic brake was tried, the result in both cases being the same according to Cone's evidence, namely, that the wheels skidded, and that when the brakes were released the wheels did not at once commence to revolve. Subsequently, however, the car was stoppd opposite the Winchester Hotel without any trouble, the line at this place being on the level. After leaving the Winchester Hotel, the line is on a slight up gradient of about 1 in 283 as far as the corner of Winchester Road, a distance of about a furlong, and from Winchester Road to the Highgate Archway (which is the next stopping place) a distance of another furlong, the road descends at an incline of 1 in 65. At the Archway the gradient becomes 1 in 22 and later on 1 in 23.

Gradients such as these, viz., 1 in 22 or 1 in 23, are by no means severe or exceptional, and tramcars can be, and usually are, controlled upon them by means of hand brakes only. In many parts of the country, tramways have been authorized by Parliament upon inclines of 1 in 10 and 1 in 9, and in such cases it is necessary to use some description of track brakes (either mechanical, magnetic or pneumatic). The practice of the officers of the Board of Trade is to insist upon track brakes being fitted to all cars which run over gradients of 1 in 15 or steeper, unless these are very short, and to cause the speed of cars while descending ordinary hills to be limited to six miles an hour as a maximum, or in the case of steep hills to four miles an hour. It is also usual for all cars to be stopped at the top of all hills with gradients of 1 in 20 or worse.

In the present instance the cars of the Metropolitan Electric Tramways Company were fitted with the magnetic track brake, not on account of the hill between Highgate Archway and the terminus, but of more severe gradients on other parts of the system. When the tramway was opened for traffic, the speed down Archway Hill was limited by Board of Trade regulation to six miles an hour. The company acted upon this regulation, and instructed their motormen to place the controller handle at the second brake notch before starting down the hill, and to retain it in that position during the whole of the descent, the resistance between the motors and the magnets having been so adjusted, that with the handle in this position the speed is limited by the magnetic brakes to six miles an hour. At the same time the company made the Archway a stopping place for all cars. The object of this stop is two-fold, (1) to ensure that cars shall enter upon the gradient between this spot and the terminus at Archway Tavern at a low rate of speed; and (2) to give the motorman ample time to apply his magnetic track brake before starting down the hill.

Cone says that near the Archway the rails became very greasy, owing to the road having been recently watered, and that when he tried to stop the car with the hand brake, he failed to do so, as the wheels skidded; whereupon he released the hand brake and tried the magnetic track brake, but as the wheels (in spite of his using sand) did not revolve, the magnetic brake was also useless. The result was that the car ran past the Archway without stopping, and, owing to the gradient of 1 in 22, the speed at once began to increase. Cone then realized that the car was getting out of control, and signalled to his conductor to apply his hand brake, which he did, but as this had no effect, the conductor released it again. Cone then reversed his motor by placing the reversing key in the "reversed" position and the controller handle on the first power notch. This had the effect, as it should, of causing the automatic switch to "blow," and Cone then moved the controller handle to the eighth power notch, which causes the motors to generate current against each other, and has a powerful braking effect. This action on Cone's part was correct and in accordance with the instructions, assuming that his other brakes had failed, but it would be absolutely useless unless the wheels were revolving and the motors acting as generators. As the wheels, according to Cone's story, were not revolving, the measures had no effect. He tried the process a second time with the same result. All this time the speed had been increasing, and about 100 yards south of the Archway, the car collided with a funeral hearse which it swept off the track and badly damaged. A few yards in front of this was a large furniture van, seeing which, Cone became alarmed for his own safety, and jumped or dropped off his car. But before doing so, he says that, as a last resort, he put the controller handle on the sixth brake notch so as to apply the magnetic brake with full force, although he knew that doing so was absolutely futile, as the reversing key was still in the reversed position, which, as already explained, renders the magnetic brake totally inoperative. Cone states that at the time he left the car the speed was "terrific," but seeing that he escaped without a scratch, this can hardly have been the case. After Cone had jumped off, the car struck the furniture van, the driver of which endeavored to escape by turning into a side street, called Harberton Road. He was, however, just too late, and the car caught the end of the van. The man at the rear of the van jumped off and escaped injury, but the horses were thrown down, and the driver flung backwards into the wreckage of the vehicle." After this the tramcar pursued its course unchecked and at an increasing speed until it ran into a Vanguard Motor Omnibus, which was standing near the bottom of the hill, forcing it across the pavement into the business premises of Messrs. Pope & Sons, Jobmasters, and Mr. Capillero, restaurant keeper, immediately after which it struck and upset a four-wheeled cab. By this time the car had reached the terminus of the tramway, where an empty tramcar was standing, and into this it dashed, driving it off the end of the line, and propelling it some forty yards down the street into Halloway Road, where the two cars, which were locked together, knocked over an electric light standard, and the post of a refuge, after which they were eventually brought to a stand against the curb of the pavement on the near side of the street.

After Cone deserted his post, there was, of course, no one to ring the bell or gong on the car, or to give warning shouts to the people in the street to get out of the way. The car, therefore, pursued its dangerous career in silence, and it is doubtless owing to this fact that so many persons were injured. The evidence is not at all clear as to how or where the three men were killed, but as far as I have been able to ascertain, they came by their fatal injuries while crossing the street at or near the spot where the motor bus was driven across the pavement and the cab upset.

Conductor Davies told me that there were about 25 passengers on the car when it started down the hill, some outside and some inside. Four or five of these jumped off near the top of the descent and were more or less hurt. Davies, who seems to have acted with good judgment, prevented the others from jumping and caused them to remain in the car until it stopped, and of these, though all of them were frightened, only one or two were hurt, their injuries being of a trifling nature.

In considering the cause of this accident, there is practically no personal evidence other than that of Motorman Cone, and the above narrative is chiefly based on his statement. Cone admits that the car was in good order when it left the depot, except perhaps as regards one of the sanders, as to which, however, his statement is, as I have already pointed out, open to doubt. But shortly after starting he had difficulty with his brakes, first with the hand brake, and then with the electro-magnetic brake, the application of both of which he says caused the wheels to skid. He further says that the wheels continued to skid even though he released the brakes and applied sand.

Conductor Griffith Davies to some extent corroborates Cone as to this, but the most conclusive evidence is afforded by the condition of the wheels after the accident, several "flats" being then found upon them. Most of these flats were slight, but one was of importance, this being on the near trailing driving wheel (as the car went down the hill) and probably caused during the final rush of the car. These flats could only have been produced by the skidding or sliding of the wheels on the rails, and as the wheels were all right when the car left the depot, they must have been due to the skidding of the wheels during the two hours that had elapsed since Cone took charge of the car. Cone attributes the whole disaster to there being something "radically wrong" with the brakes, the defect being not only such as to cause the wheels to skid when either the hand or magnetic brakes were applied, but also to prevent the wheels from revolving after the brakes had been released. Such a statement is easy to make, and requires careful scrutiny.

The brakes were found to be in working condition after the accident. In spite of the damage the car had sustained it was driven back to the depot, a distance of over four miles, immediately after the accident, and though the magnetic shoes of the brake were displaced and twisted, and the hand brake spindle and the controller and one end of the car knocked out of place, the brakes were still capable of being worked from the other end of the car. I subsequently examined the brakes and brake gear and also the wheels, and I could find no actual defect other than the flats on the wheels (which, however, could have had no effect in preventing the wheels from revolving). The hand brake gear or rigging in no way differed from that in use upon thousands of cars now running. It probably was in better condition than is often the case, but it had all the unmechanical features which are characteristic of most tramway hand brakes. Owing moreover to the newness of the blocks and to their being adjusted so as to clear the wheels by 1/16th of an in. when not in use, the brakes were in a condition which required more care than usual in their manipulation.

Brake blocks are of cast iron, and are used in the rough condition in which they leave the molds. New blocks are therefore always inclined to be "fierce" in their action, that is to say, the friction between them and the wheels is greater than is the case with blocks that have been in use for some time ,and have been worn smooth. The result is that with new blocks a very slight pressure either by means of the hand brake handle, or by the drag of the magnetic shoe, is sufficient to cause the wheels to skid, and the greatest possible care and skill is therefore needed in handling the brakes. Moreover, the blocks being set at only 1/16th of an inch from the wheels, the back springs, the object of which is to pull the blocks away from the wheels when the brake handle is released, would hardly be compressed at all when the brake was applied, and would practically have little or no effect in freeing the blocks from the wheels. It might therefore easily happen that even though the motorman had released the brake handle, the blocks, or some of them, would not instantly leave the wheels, but would continue to rub against the latter and prevent them from revolving. The tendency of the blocks to skid the wheels is increased by the position in which the blocks are hung, namely, below the centers of the wheels. A small amount of friction between the blocks and the wheels is sufficient to produce a dragging movement on the blocks in the direction of the revolution of the wheels, and when, as must be the case with at least four out of the eight wheels, the motion of the periphery of the wheels in contact with the blocks is upwards, the effect is to jam these blocks tightly against the wheels. I believe that this method of hanging the brake blocks was adopted for the express purpose of producing the effect referred to, under the idea that the efficiency of the brakes was thereby automatically increased. In my opinion the arrangement is altogether wrong, as it is certain to cause skidding, and takes it out of the power of the motorman to graduate the pressure of the blocks on the wheels. In railway practice the brake blocks are usually hung so as to be opposite or the least bit above the centers of the wheels, so as to avoid this effect. The importance of keeping the blocks normally well clear of the wheels is referred to by Galton, who says in the papers already mentioned (see page 2) "to prevent retardation from the dragging of the brake blocks against the wheels when the brakes are not in use, care should be taken that the brake blocks are kept well clear of the

wheels (say half an inch) when in a state of inaction." It therefore seems to me that the attempt to adjust the brake blocks of tramcars to within 1/16th of an inch is a mistake. Further, having regard to the rough and ready method of making this adjustment and to the lack of careful design and fitting of the whole rigging and gear of the wheel brakes (which defect is common to nearly all tramcars), it is quite impossible for the blocks on all the eight wheels of a car to be adjusted correctly within such a narrow limit. As the blocks become worn this space becomes greater, and at the same time the tendency of the blocks to cause the wheels to skid, and to hold them skidding, decreases, partly on account of the blocks being worn smooth, and partly, also, because, when released, they are well clear of the wheels.

There is another cause common to all electric cars tending to promote skidding and to hinder the wheels from commencing to revolve as soon as the brakes are released, which must not be overlooked; I mean the inertia of the heavy armatures of the motors and the friction of the gearing between the driving wheels and the armatures, both of which retarding forces have to be overcome, when current is not being supplied to the motors, by the adhesion between the wheels and the rails. The condition of the rails, whether dry or greasy, is also a most important factor in connection with the skidding of the wheels.

Taking all these things into consideration, it will be understood that the brakes on car No. 115 required the skilful handling of an experienced motorman.

It is now well known that the retarding effect of a wheel sliding upon a rail, or skidding, is very much less than when the wheel is braked with such a force as will just allow it to continue to revolve. This was established by Galton in the experiments made by him in 1878, and the explanation is given in the papers read by him in that and the following year. (See page 2.) Skidding, therefore, entails a serious loss of braking power. If the co-efficient of friction between the blocks and the wheels were a fixed quantity, it would be easy to regulate the pressure of the blocks on the wheels so as to avoid skidding. But, unfortunately, the friction between the blocks and wheels varies inversely as the velocity of the latter. Consequently, when the wheels are revolving rapidly, greater pressure is required between the blocks and the wheels than when the latter are revolving slowly. For this reason the utmost care is at all times required to regulate the pressure of the brake blocks on the wheels according to the speed, so as to avoid skidding. There is at present no way of letting a motorman know what pressure he ought to put, or is putting, on the blocks; it is a matter of guesswork, or, to put it a little higher, of judgment based on experience. A novice will be constantly locking his wheels and causing flats. Some men never get beyond this, and, thereby proving themselves unsuited to the business, are not retained in the tramway service. Others gradually learn by practical experience how to manipulate the brakes under all the varying circumstances that arise so as to obtain the best results, and these make successful drivers.

Cone's training consisted of eleven lessons of about one hour each in the school, namely, from April 23 to May 4, and twelve lessons (amounting to 98 hours) on the road. On May 19 he was certified as having been "thoroughly instructed in the duties of a motorman and now competent to take charge of a car." He then had three days' practice on a car on the Archway route with another motorman (including one day's instruction in the use of the magnetic brake), and on May 28 he commenced regular duty in charge of a car. He had been in regular work for 20 days up to June 23, on which date the accident occurred.

The above training may have been sufficient to make a fair-weather motorman of Cone, but it evidently had not taught him the principle of the magnetic brake* or how to manage a car when difficulties arose, nor did it give him confidence in himself and in the appliances at his disposal when danger threatened.

On passing the Archway, Cone says he tried to stop his car, firstly by the hand brake, secondly by the magnetic brake, thirdly by reversing the motors, &c., fourthly by repeating the reversal of the motors, and lastly by re-applying the magnetic brake while the motors were reversed. These actions must have been performed in rapid succession, so that there was no time for any one of them (except the last) to take effect; and as to the last, it was wholly useless, as the magnetic brake was inoperative while the reversing key was in the "reversed" position. If Cone did all these things in the manner stated, it is not surprising that he entirely failed to stop or even check the speed of the car. He merely wasted valuable time to no purpose.

What I believe really happened was, that Cone applied the hand brakes near the Archway with too great pressure, and that the newness of the blocks and the greasy condition of the rails immediately caused the wheels to skid; that though he released the hand brake he did not succeed in doing so completely, with the result that the rear driving wheels remained skidding; that he then got confused and turned the handles various ways without exactly knowing what he was doing; and that his nerves completely failing him, he jumped off the car, and left it so far as he knew without any brakes on at all, although judging from the flat afterwards found on one of the rear driving wheels, these probably skidded all the way down the hill.

I am therefore led to the conclusion that the origin of all the trouble is to be found in the fact that the brake blocks were new, and were adjusted with insufficient, and probably unequal clearances, from the wheels. From these causes, combined with a greasy rail, arose a condition of affairs which had not previously come within the scope of Cone's training and experience. He evidently did not know how to deal with it, and blundered egregiously. His action in deserting his post and allowing the car to descend the hill unbraked and silent was particularly reprehensible. He can only be excused on the score of insufficient experience and loss of nerve.

If Cone, immediately on finding at the Archway that the wheels were skidding, had been careful to entirely release the hand brake, and to give a plentiful supply of sand to the rails so as to cause the wheels to revolve, and had then applied his magnetic brake with gradually increasing force, I have no doubt that the car would have been under proper control, and would have descended the incline with perfect safety. Even at the time when he jumped off the car, if he had placed the reversing key in the forward position before applying the magnetic brake, it is probable that speed would have been very much reduced by the time the car reached the foot of the hill.

This disaster, and others of a similar nature, which have recently occurred, have caused a great deal of attention to be directed, both in Parliament and in the public press, to the subject of brakes on tramcars. Much adverse criticism of tramway authorities has been let loose, and it has been suggested that the latter have hitherto failed in their duty, and that they should at once be "compelled to use the most instantaneous and efficient method of arresting the progress of a tramcar." It perhaps is fortunate that no means are available whereby the progress of a tramcar moving at high speed can be instantaneously arrested, as the result would be as bad as a collision.

In regard to this particular case, it is fair to the company to say that they had already equipped their cars, at very considerable expense, with one of the most modern braking appliances known, viz., the electro-magnetic brake, the nature of which I have already described. The chief objection to this appliance, in common with all descriptions of electric or magnetic brakes which require the motors to act as generators, is that its action depends entirely upon the rotation of the wheels, and that the moment the latter cease to revolve the brake is inoperative. As there is always the risk that an incompetent or nervous motorman will skid the wheels of his car by the application of the hand brake, the question arises whether, in spite of their many merits, brakes of this class can be considered as the most suitable for use on steep gradients; or whether some other form of brake, altogether independent of the revolution of the wheels, is not better adapted for such places. At any rate, where brakes of this class are adopted, it seems desirable that they should be in regular and constant use, and not merely reserved for emergency stops. It is only by such regular use that their maintenance in a condition of efficiency can be secured, that defects can be discovered, and that the motorman can gain experience in their use, and confidence in their action. I am disposed to think that it is a mistake in tramway practice to regard any brake as an "emergency brake," and as one which is only to be used on rare occasions. When this custom is followed there is a risk that the brake will either be wrongly applied, or for some reason or other will fail, when the occasion for its use arises. In tramcar driving the "emergency" is ever present, and motormen should be permitted to use at all times the most powerful braking device at their disposal.

Mr. Fell, the Chief Officer of the London County Council Tramways, whose experiments with the electro-magnetic brake have already been referred to, was impressed with the desirability of obtaining a brake which does not depend entirely on the rotation of the wheels, and in a paper read before the Tramways and Light Railways Association on January 10, 1906, said: "I shall not feel satisfied (with the electro-magnetic track brake) until a supplementary attachment is provided, so that the magnetic track brake shoes can be operated by hand, if necessary." I agree with Mr. Fell, and am convinced that if the electro-magnetic brake is to be a complete success and thoroughly reliable on gradients, some such addition to it is necessary. The brake would then become a combination of the magnetic brake with the mechanical hand brake, and the shoes would be at all times available for use in the same way as those of an ordinary track brake, even when the wheels were skidding, or when, for any reason, the electro-magnets failed.

Judging from the remarks one hears, it would seem that an idea is abroad that greater brake power should be given to the motorman. If by this it is intended that he should merely have means of applying greater pressure to the brake blocks, it is doubtful whether such a provision is necessary or desirable. The ratio between the pressures on the hand-brake handle and on the brake blocks is already, judging from the frequency with which the wheels are skidded, more than sufficient. The only result, under present conditions, of giving the motorman more power would be that the wheels would be skidded still more frequently. The possible amount of retardation due to the wheel brakes is entirely governed by the adhesion between the wheels and the rails, and the greatest effect in stopping a car is produced when the friction between the brake blocks and the wheels amounts to a quantity just short of the adhesion between the wheels and the rails (Galton). It is therefore useless, and, in fact, detrimental to give the motorman power to increase the pressure of the brake blocks, unless at the same time the adhesion between the wheels and the rails can be increased. This can only be done in two ways (1) by substituting steel-tired wheels for the chilled wheels—the coefficient of friction between cast-iron chilled wheels and steel rails being less than between steel wheels and the rails* (this is, of course, only applicable to those tramways on which chilled wheels are used); (2) by the use of sand. But when all has been done, there is a limit to the adhesion between the wheel and the rail which puts a limit to the possible amount of braking effect obtainable from the wheel brakes. The wheel brakes may be supplemented by track brakes, either mechanical or magnetic, the retardation thus afforded being due to the friction between the shoe and the rail, which is equal to the pressure of the shoe multiplied by the coefficient of friction between the shoe and the rail. This coefficient not only depends upon the material of which the shoe is constructed, but also varies inversely as the speed; the higher the speed, the less the coefficient of friction and vice versa. Here also a limit of effective power is soon reached, for it must be remembered that all track brakes (other than the magnetic) depend upon the weight of the car for the pressure exerted upon the rails, and in fact deprive the wheels of a portion of this weight, and to that extent rob the wheels of some of their braking emergency. When therefore the track brake is applied, the pressure of the brake blocks on the wheels must be reduced if skidding is to be avoided. If all the weight is carried on the track brakes, the wheels will be lifted off the rails and be useless for braking purposes; on the other hand, if all the weight is carried on the wheels, the track brakes are equally useless. What the mean between these extremes should be does not appear to have ever been decided. It follows that the advantage gained by the use of the ordinary track brakes lies chiefly in the higher coefficient of friction, which can be obtained by the choice of suitable material for the shoes over that existing between the wheels and the rails; this higher coefficient being applicable to so much of the weight of the car as is carried upon the track brakes.

With the electro-magnetic track brake the conditions are somewhat different, as the pressure of the shoes on the rails depends solely upon the magnetic attraction between them, and has nothing whatever to do with the weight of the car, so that the braking efficiency of the wheels is not affected.

Another appliance which has considerable importance in retarding and stopping tramcars is the sander. Sanders are almost invariably operated by a pedal worked by the left foot of the motorman, but an automatic sander for use with the electro-magnetic track-brake is now being experimented with. In some cases they are wasteful of sand, in other cases they do not deliver enough sand unless the driver continues to move the pedal rapidly up and down. Moreover, the sand is delivered on the rail at some distance from the wheels, whereas on a locomotive care is taken that the sand shall be dropped as close to the driving-wheel as possible. When it is remembered that the driver has to ring the dangergong or bell by means of a similar pedal, also worked by the left foot, and that on some cars he has a device for releasing the life-guard, also operated by the same foot, and that he has to control the "dog" or pawl engaging with the ratchet-wheel at the foot of the hand-brake spindle with the right foot, while with his left hand he works the controller handle, and with his right hand the brake handle, and that all these actions may in times of emergency require to be performed simultaneously, it would seem that he may be called upon to do what

*When giving evidence before the Coroner, Cone was asked whether "the magnetic brake acts independently of the electric current from the trolley-wire," to which he replied, "I do not know that."

*I have been unable to find in any text-book what the coefficient of friction is between chilled wheels and steel rails, but it is known to be less than that between steel wheels and steel rails.

is in fact impossible. It seems hardly credible in these days of engineering inventiveness that with so large an amount of power in the form of electric energy available upon a car, all these operations should still have to be performed in such a primitive fashion.

I suggest that the whole subject of brakes, sanding arrangements, etc., on tram cars might with advantage be taken up by the Municipal Tramways Association in conjunction with the Tramways and Light Railways Association, or else by the Engineering Standards Committee, and dealt with in a scientific manner.

THE PERFORMANCE OF ASSISTANT CYLINDERS, WITH SPECIAL REFERENCE TO THOSE ON THE U. S. CRUISER "WASHINGTON."*

By W. W. Smith.†

The "Washington" is the first naval vessel fitted with Lovekin assistant cylinders for floating the valve gear to relieve it of the load under which it works. As the engines of the "Washington" are of higher power, and the forces acting on the valve gear much greater than on any other engine to which these cylinders have been fitted, the results of a test of these cylinders should prove of interest.

The object of the assistant cylinder in relieving the valve gear of its load is to reduce the wear on the bearings and the consequent expenses. At high speeds the valve gear works under an enormous load, which is due chiefly to the inertia of the heavy moving parts. This load on the valve gear causes considerable friction, a great deal of wear on the eccentric bearings, and much repairing and renewals.

The action of the assistant cylinder is similar to that of a spring dash-pot. The steam in the cylinder is the elastic medium, which, when compressed acts as a spring. This spring-like action of the steam is such that the predominating force in the cylinder is always approximately equal to the forces acting on the valve gear, but is exerted in an opposite direction. Consequently, the forces acting on the valve gear are neutralized, the valve gear is "floated," and the loads on it are diminished.

THE CONSTRUCTION AND PIPING OF THE ASSISTANT CYLINDERS IN THE U. S. CRUISER "WASHINGTON."

CYLINDER.—Referring to Figs. 1 and 2, the assistant cylinder and the valve-chest cover are cast in one. The sides and top of the cylinder are lagged.

STEAM-SUPPLY PORT.—An annular steam-supply port is located about the middle of the cylinder. This port opens into an annular space into which the steam-supply pipe is led.

PISTON.—The piston is a little different from ordinary pistons, the cylindrical surface of the piston being extended above the conical part and connected to it by four webs. Just above the conical part of the piston an annular space is cut for the purpose of admitting steam above the piston. The piston is fitted with three cast-iron snap rings as shown.

PISTON ROD.—The balance-piston rod is part of the valve stem, both being made from one piece of metal.

PACKING.—Between the assistant cylinder and the valve chest the rod is packed with U. S. metallic packing.

PIPING.—The steam-supply pipe leads into the annular steam port of the cylinder. All of the cylinders are supplied with steam at the same pressure from a differential valve on the steam-chest side of the throttle valve. Thus steam is admitted to all of the assistant cylinders at once. A relief valve is fitted on the supply pipe near the differential valve.

DRAINS.—The drain pipes are led into the top and bottom of the cylinder, and are fitted with valves. A relief valve is fitted in the drain pipe near the cylinder. Both the supply and drain pipes have couplings at the cylinder, so that they can be disconnected when the valve chest cover is taken off.

DIFFERENTIAL VALVE.—The object of the differential valve is to supply steam to the assistant cylinder at a pressure lower than the pressure in the high-pressure valve chest from which the supply of steam is taken; also to regulate the pressure so that a constant ratio between the pressure of the steam in the high-pressure valve chest and the supply-steam pressure is always maintained. The reason for the latter is that as the inertia and the receiver pressure both vary as the square of the revolutions, the inertia varies as the receiver pressure, and if the inertia is balanced at one speed it will be balanced at all speeds.

The differential valve consists of a piston with the steam from the valve chest acting on a small area and the supply steam acting on a larger area. When the two pressures differ by the constant ratio, the piston is exactly balanced. If the supply-steam pressure is too low, the piston moves and admits steam into the supply piping, and when the supply-steam pressure rises above its relative pressure the piston moves back and shuts off the steam.

PERFORMANCE OF THE ASSISTANT CYLINDERS.

Without considering the results of the analysis of the indicator cards, the performance of the assistant cylinders, judging from the easy working of the valve gear, was excellent. There was no noise or jar in the working of the valve gear, and especially at the bottom of the stroke, where the forces acting on the valve gear are considerable.

The performance of the assistant cylinders for various speeds is shown in the curves of loads on the valve gear, Figs. 3 and 4. As these curves clearly show the excellence of the performance, very little need be said on this subject.

BALANCE AT FULL SPEED. For the H. P. cylinder the "mean load" is less than ⅛ of the load on the valve gear when the engine is at rest. By the use of assistant cylinder the "mean load" is reduced from 4,600 lbs. to 958 lbs. The "maximum load" is only ⅔ of the load on the valve gear when the engine is at rest. By the use of the assistant cylinder the "maximum load" is reduced from 10,600 lbs. to 2,200 lbs.

For the I. P. and L. P. cylinders the "mean load" is about half of the load on the valve gear when the engine is at rest. By the use of the assistant cylinder the "mean load" is reduced from 6,800 lbs. to 2,500 lbs. The "maximum load" is about the same as the load on the valve gear when the engine is at rest. By the use of the assistant cylinder the "maximum load" is reduced from 16,400 lbs. to 5,100 lbs.

BALANCE AT CRUISING SPEEDS.—The revolutions for cruising speed will be between 65 and 80. The balance for cruising speeds, although not so good as at full speed, is very satisfactory. For the H. P. the "mean loads" are from ⅛ to ¾ of the load on the valve gear when the engine is at rest, and the "maximum loads" are reduced from 5,300—6,500 lbs. to about 4,100 lbs.

For the I. P. and L. P. the "mean loads" are 0.98 to 0.9 of the load on the valve gear when the engine is at rest, and the "maximum loads" are reduced from 7,900—10,000 lbs. to 6,800—7,200 lbs. At these speeds it will be noticed that the "maximum unbalanced loads" are the greatest.

It will also be noticed that with balance cylinders the load on the valve gear is evenly distributed throughout the complete revolution. This is an important consideration, as it obviates the uneven load and excessive pressure on the bearing at the bottom of the stroke.

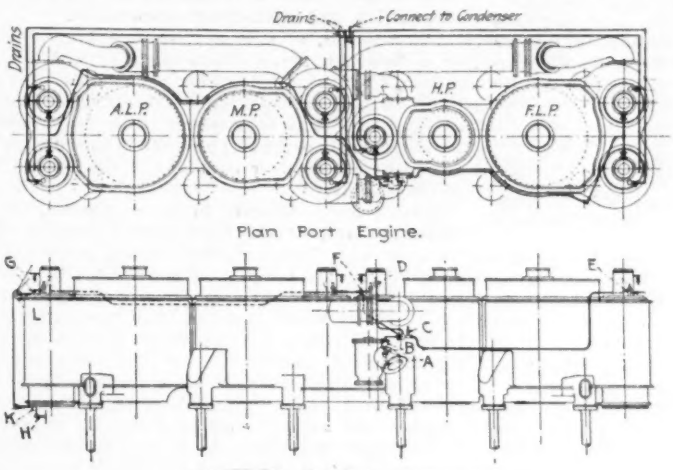
Theoretically, the balance at all speeds obtained by using the assistant cylinder is nearly perfect. The one difficulty is regulating the pressure of the supply steam. Even when the pressure of the supply steam is regulated by the pressure in the first receiver the regulation is not perfect. Various conditions, such as changing the setting of the independent cut-off, alter the pressure in the receiver, so that this pressure does not always bear a fixed relation to the revolutions.

DISADVANTAGES.—The disadvantages of assistant cylinders, which are the same as for balance cylinders, are:

(1) Initial cost.
(2) Complication and more parts.
(3) More weight and space required.

ADVANTAGES.—The above disadvantages are more than compensated by the following advantages:

(1) The reduction of wear on the valve gear, and consequently the cost of maintenance and up-keep.



FIGS. 1 AND 2. PLAN AND ELEVATION OF THE PIPING FOR THE ASSISTANT CYLINDERS IN THE U. S. CRUISER "WASHINGTON."

A—Special connection and stop valve connected between throttle and engine.
B—Differential regulating valve supplying steam to asst. cylinders.
C—Relief valve on steam line.
D—Stop valve for steam at each asst. cylinder.
E—Relief valve on bottom drain pipes at each asst. cylinder.
F—Stop valves on top and bottom drains at each asst. cylinder.
G—Indicator connections for obtaining diagrams from cylinders.
H—Pin in valve stem or cross-head for attaching indicator cord.
K—Guide pulleys for indicator cord.
L—Reducing wheel.

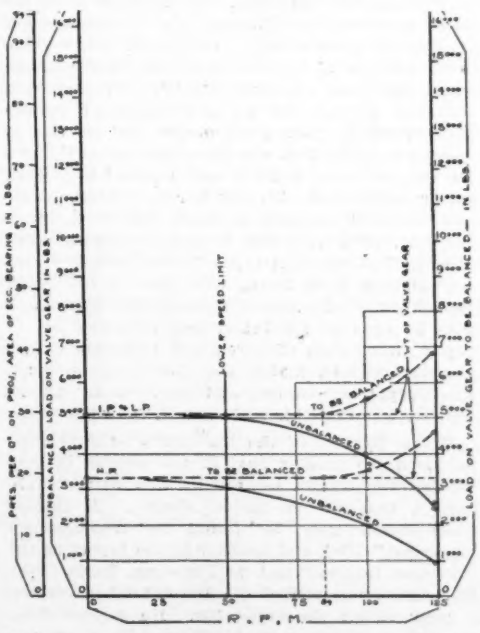


Fig. 3. Curves of Maximum Loads on the Valve Gear, Showing the Performance of the Assistant Cylinders for Various Speeds.

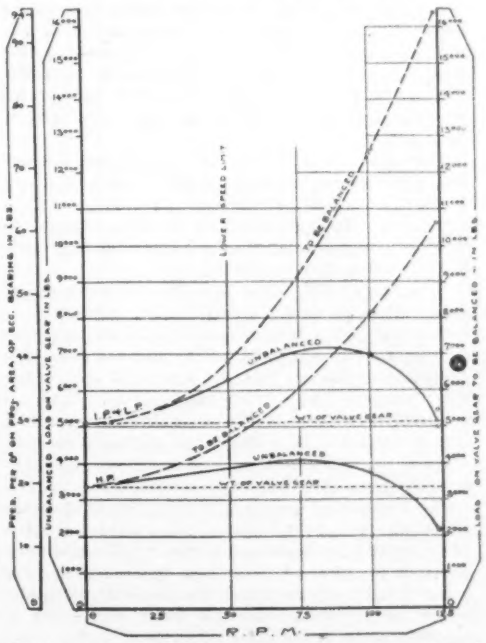


Fig. 4. Curves of Mean Loads on the Valve Gear.

(2) The liability to break-down in the valve gear is greatly reduced.

In comparing the economy of the assistant cylinder with the balance cylinder, the following may be added to the above advantages: (3) Smaller and lighter cylinders may be used.

(4) The initial cost is less in case of large cylinders.*

APPLICATION.

MERCHANT VESSELS.—Assistant cylinders have been fitted on several merchant vessels—notably, the Pacific

*Condensed from an article in the "Journal of the American Society of Naval Engineers."
†Ensign, U. S. N.

Mail steamships "Manchuria" and "Mongolia." The primary consideration, whether to or not to fit assistant cylinders on merchant vessels is that of economy. From the results of the ships on which these cylinders are installed, and the performance of the assistant cylinders on the "Washington," it seems that there is considerable economy in their use. In comparison with balance cylinders, it seems that for about the same or less cost assistant cylinders give better results and better economy.

NAVAL VESSELS.—In naval vessels, weight and space are of primary importance. The feasibility of applying assistant cylinders to naval vessels has been demonstrated on the "Washington," the "Kansas" and the "New Hampshire," on which these cylinders are being fitted.

In comparison with balance cylinders, assistant cylinders are much more desirable, as they are lighter and relieve the loads on the valve gear more efficiently. The latter is important, as it reduces the liability to breakdown from the valve gear and also reduces the overhauling necessary.

STATIONARY ENGINES.—Assistant cylinders are also applicable to stationary engines where the loads on the valve gear are considerable, and in many cases their use would be advantageous.

THE BUDAPEST CONFERENCE OF THE INTERNATIONAL GEODETIC ASSOCIATION.

By O. H. Tittman* and John F. Hayford.*

The fifteenth general conference of the International Geodetic Association was held at Budapest Sept. 20-28, 1906. Such conferences of the Association are, in general, held at intervals of three years. The following brief account is confessedly more or less unbalanced and incomplete, but it has been thought worth while to call attention to some of the more important features of the meeting.

There were present 61 delegates, representing 18 nations. Nearly every part of Europe was represented, as well as Japan, Mexico, the United States and Argentina. Argentina was represented in the Association for the first time at this meeting.

The activities of the conference may conveniently be grouped in four classes—first, the presentation by the representatives of the different countries of the reports of the progress in geodetic operations during the past three years in those countries; second, the presentation of special papers bearing upon improvements in instruments, methods of observation and methods of computation; third, the transaction of the business of the Association itself at the conference in connection with the continuous operation of the Central Bureau maintained at Potsdam and in connection with the field work being done by the Association as an organization; and, fourth, the social features of the meeting.

Through this and similar conferences a close and effective cooperation of many men of many nations, acting as an association, is secured in a certain few lines of research, of which the greatest now being carried forward is an investigation of the variation of latitudes.

The Association does not fix the methods of observation or computation in any country. It controls only the methods used in its own Central Bureau and in the field work paid for from the Association funds. But, by virtue of the active interchange of ideas which takes place at the conferences, the Association undoubtedly exerts a strong influence in making the methods used in various countries much more uniform and progressive than they otherwise would be.

The reports of progress within the past three years which were submitted show that the rates of progress in accumulating new results are very different in different countries, depending upon a great variety of conditions. Each country brought some contribution, and the total represents a rapid increase in the mass of geodetic facts available for future use. It would be tiresome even to summarize these reports here, and the summaries would be of little value. Three items are, however, of special interest. Progress has been made within the last three years in the observations and computations connected with an arc in Spitzbergen, and, in connection with the remeasurement of the classical Peruvian arc, extended. Progress has also been made in South Africa on the measurement of an arc which is expected ultimately to extend from the Cape of Good Hope to the northern part of Russia, a total length of 104°.

Let us turn now to the special papers bearing upon improvements in instruments, methods of observation, and methods of computation.

Th. Albrecht, of Germany, presented a report on a thorough investigation made at and near Potsdam of the applicability of wireless telegraphy to the accurate determination of differences of longitude. The transmission time was found to be extremely small and sensibly independent of the particular receiver used and of the intensity of the sending.

Though not a delegate to the conference, Ch. Td. Guillaume, of the International Bureau of Weights and Measures, by special invitation, occupied the greater part of one session in presenting the results of the many tests of the Invar (nickel-steel) wires made at the International Bureau, describing the apparatus devised there for the rapid measurement of the bases with Invar wires and in explaining its use in the measurement of a base extending the entire length of the recently completed Simplon tunnel. The extensive investigations at the International Bureau show that the changes in length to which the Invar wires are subject are so small and that the Invar wires have such physical properties that they are suitable for the measurement of primary bases. The experience in the Simplon tunnel confirms this conclusion. The base apparatus there used is elaborate in comparison with that now in use in the United States for the measurement of primary bases with steel and Invar tapes. It also differs radically from the Coast and Geodetic Survey (U. S.) apparatus, in having the entire measurement carried forward on movable tripods, just as measurements with base bars are made, instead of being carried forward on stakes driven in the ground, as in the tape measurements in the United States.

The Simplon tunnel base was 20 kilos. long. The tunnel was placed entirely at the disposition of the measuring party for five consecutive days, no trains being run during that time. The measurement was made continuously in each direction through the tunnel, the party working in shifts of 8 hours, day and night. The forward measurement was made in 59 hours. The remeasurement was made, after a day of rest, in 27 hours. The total number of persons employed on the measurement at any one time was 28. Seventy-seven different persons in all were involved in the measurement. This performance and its results leave no doubt that the necessary accuracy can be secured more quickly and conveniently with Invar wires than with any bar apparatus. Anyone who will carefully compare this work, in all respects, with what has been accomplished with steel and nickel-steel tapes in the United States on primary base work, will also be convinced that all the advantages claimed for wires may also be claimed for tapes, and that the use of tapes rather than of wires, and of stakes rather than of tripods, makes the measurement much more rapid, economical and convenient. Tapes, too, are more reliable as to length than the wires.

Baron Eötvös, of the University of Budapest, occupied the greater part of one session in presenting the results secured by him with certain torsion balances of special design. A similar presentation may be found in Wiedemann's "Annalen," 1896, and another in the report of the Congress International de Physique, Paris, 1900. The conference visited the Baron's laboratory in a body to see the apparatus. He derives from the observations the first differentials of gravity with respect to the distance measured along the three rectangular axes at the point of observation. From these observed quantities may be derived various other quantities, such, for example, as the radii of curvature of the geoid at the point of observation. The claims made as to the simple manipulation of the apparatus, the accuracy of the results, and the certainty with which the positions of the excesses and defects of mass within the earth may be determined by such observation, are astonishing. If the validity of these claims be established by future investigations, these torsion balances will become very important as being the most powerful means available for determining the distribution of density within the earth.

Dr. O. Hecker exhibited the very interesting apparatus which had been used by him, under the direction of the Association, for determining the value of gravity at sea. He presented the results of recent observations made with this apparatus on the Pacific on two voyages between Sydney, Australia, and San Francisco, and between San Francisco and Yokohama. The atmospheric pressure is determined in terms of millimeters of mercury by a mercurial barometer and simultaneously the pressure is also determined in absolute units by an accurate observation of the boiling point of water, using mercurial thermometers. From these simultaneous observations the intensity of gravity and the point of observation are computed. This method is entirely successful in determining gravity with the accuracy necessary for an effective study of the anomalies in gravity, and it is the only successful method yet devised for determining gravity at sea with sufficient accuracy. Such observations are of extreme importance to geodesy, because they are the only geodetic measurements possible over three-fourths of the globe.

Hecker's observations show that, in general, over the deep Pacific gravity has nearly its normal value, as computed by Helmert's formula of 1901, fixing the relation between gravity and latitude. Parenthetically, it may be remarked this indicates that the condition called isostasy exists. Four regions with large anomalies, with reference to Helmert's formula, were found. On Oahu, one of the Sandwich Islands, and on the surrounding sea, there is excessive gravity. There is also a region of excessive gravity in shallow water near New Zealand. Over the submerged Tonga plateau, where the depth is 3,000 meters, gravity is largely in excess, and in the adjacent Tonga deep (5,000-10,000 meters) there is a large defect of gravity.

H. Kimura, of Japan, reported on a harmonic analysis of the variation of latitude which was made by him. The analysis develops the very interesting fact that in addition to its other motions, already approximately known, the pole has a reciprocating motion nearly along a straight line, with a period of about 0.75 year—a period which is not commensurable with any of the other known periods of the polar motion.

Lallemand, of France, for many years the authority on precise leveling, stated that a series of experimental comparisons had been made in France between the French instrument and method and the instrument and method used in the U. S. Coast and Geodetic Survey since 1900. The conclusion reached was that the degree of accuracy is sensibly the same in the two cases, because in each the instrumental errors have been so small that the errors in the results are mainly due to meterological conditions; that is, to conditions between the object glass and the rod.

On the part of our own country, the United States, there was presented a special report upon a recent determination of the figure of the earth, made by the Coast and Geodetic Survey and based entirely upon deflections of the vertical observed in the United States. This report showed that to secure the highest degree of accuracy in such determinations the theory of isostasy must be taken into account; that the United States is not maintained in its position above sea level by the rigidity of the earth, but is, in the main, buoyed up, floated, because it is composed of material of deficient density; and that the defect of density is limited to the depth of 71 miles, if it be uniformly distributed with respect to depth. This report, if it be convincing, must ultimately produce radical changes in the methods of computation used by geodesists. It also has a direct bearing upon several of the greater problems of geology and of geo-physics.

The activity of the Association itself, as distinguished from the activities represented by reports of progress and special papers, is indicated by the fact that the average rate of expenditure

*Mr. O. H. Tittman, Supt. of the Coast and Geodetic Survey, Washington, D. C., and Mr. John F. Hayford, Inspector of Geodetic Work, Washington, D. C., were the representatives of the United States at the conference.

for the past three years has been $19,000 per annum. This covers administration, printing and postage, the maintenance of the Central Bureau and such field work as is paid for by the Association.

The principal work of the Central Bureau, under the direction of Dr. F. R. Helmert, may be summarized as follows:

Relative gravity determinations in various countries have been furthered by special examinations in detail of apparatus to be used for this purpose and by instructing the observers.

Prof. Borrass has been occupied in studying the existing relative gravity determinations with a view to their proper combination in a gravity net extending over the globe.

A systematic study of deviations of the vertical in Europe has been continued by Prof. Börsch, and progress has been made in the publication of the results.

A systematic study by Dr. Helmert of the curvature of the geoid along certain meridians and parallels in countries where there is extended triangulation has been nearly completed.

The determination by Dr. Kühnen and Dr. Furtwängler of the absolute value of gravity at Potsdam, which has been in progress for several years, has been completed and the final results are now being printed. In these determinations five different pendulums have been used at Potsdam, and a very extensive series of observations have been made with great care. It was found that the general experience of the past was repeated, and that systematic differences, much too large to be accounted for as errors of observation, were found between the results from different pendulums.

In trying to account for the large residual furnished by one of the five pendulums, which was of peculiar form, the suspicion arose that possibly the stem of this pendulum was subject to flexure, as the pendulum took various positions during each swing. Accordingly, a mathematical theory of such a possible flexure was developed fully for the first time. The effect of the flexure upon the value of gravity given by each of the five pendulums was then computed, using this mathematical theory, which expresses the effect in terms of the modulus of elasticity of the material composing the stem, the dimensions of the stem and the masses of different portions of the pendulum. The corrections brought the results into closer agreement.

The same theory was, with similar success, applied to six other series of pendulum observations made at various times and at places connected with Potsdam, by accurate relative determinations of gravity. In these series pendulums of various designs have been used. The adopted value of gravity at Potsdam is a simple mean of the seven values, one of these being the value observed at Potsdam. The adopted mean differs by one part in 250,000 from the Potsdam determination. Helmert states that he believes the possible error of the adopted mean to be less than one part in 100,000. The total range of the seven values is one part in 33,000. Two of the seven values depend upon observations made with the Bessel ball and wire pendulums. For these the complete theory developed by Bessel for taking account of the flexure of the wire was used without modification.

The gravity determinations at sea by Dr. Hecker, already referred to, were made under the direction of the Central Bureau and paid for by the Association.

The principal field work supported by the Association is the determination of the latitude variation. For the latitude observations and the necessary computations of them, made at the Central Bureau, the expenditure has been, on an average, $14,000 per year during the past three years; this is more than two-thirds of the total expenditure of the Association. From 1899 to date observations have been made continuously at six stations, all in latitude 39° 08' North and surrounding the pole. In 1906 two stations in the southern hemisphere were established, one in Argentina and one in Australia. The observations at all of these eight stations will be continued at least until 1909. The accuracy with which the motion of the pole is followed by these observations may be inferred from the fact that Kimura writes with confidence that a movement having a period of 0.75 year exists, though its total amplitude is apparently 0.06" (6 ft.) or less.

By a formal resolution, transmitted to it in advance of this meeting, the Association was asked by the International Association of Academies in what way it could sustain or promote international cooperation in the following two matters: (a) Leveling of precision in chains of mountains subject to earthquakes, with a view of determining whether such chains are subject to changes in elevation; (b) measurements of the value of gravity for the purpose of throwing light upon the internal distribution of terrestrial masses and upon the rigidity or isostasy of the crust of the earth. This resolution is the result of action taken at the International Geological Congress held in Vienna in 1903.

A special report on that part of the resolution which refers to leveling was, by request, prepared in advance by Lallemand, of France. He set forth the rather discouraging past experience in this line and indicated the essential difficulties of the problem. He reported that determinations of the stability of the ground by means of precise leveling, repeated at long intervals, should be made in all regions, not simply in chains of mountains subject to earthquakes; that ordinarily a general change of elevation of less than 1 decimeter cannot be detected with certainty; and that each country should repeat the leveling, over at least the principal lines of its precise level net, two or three times in each century.

Darwin, of England, prepared in advance, by request, a report on that portion of the resolution which refers to gravity determinations. He suggested a resolution to the effect that the Association welcomes the resolution transmitted to it, as showing that geodetic observations throw light on the science of geology, and that the Association further desires to impress on geodesists who may be planning future gravity observations that it is desirable that the sites for observation be chosen with reference to such use of the observations.

The recommendations made by Messrs. Lallemand and Darwin were incorporated in a resolution passed by the Association. At the suggestion of Darwin, the resolution, as passed, also definitely recognized that observations of the direction of gravity—that is, of deflections of the vertical—may also be used in determining the isostasy or rigidity of the crust of the earth, as well as observations of the intensity of gravity.

Nearly all of the party lived at the same hotel. Numerous social functions also kept the party together and served to make the delegates acquainted with each other. Among the social functions were a reception by the Archduke Josef at the Royal Palace, a dinner given by the city of Budapest, a dinner given by Count Apponyi, the Minister of Public Instruction; an informal dinner given by the delegates in honor of their entertainers, an evening of Hungarian opera, and several afternoon excursions.

The surroundings in which the conference met were especially interesting. Budapest, the Hungarian capital, is a rapidly growing modern city, with all modern improvements. One finds in it an intense national life, and at the same time many interesting evidences of the influence of several different civilizations. Eleven different languages are officially recognized by being printed upon the paper money.

FILTERED WATER FOR ALL OF WEST PHILADELphia was turned into the supply pipes for the first time on Nov. 6. All that section of the city lying west of the Schuylkill River now receives a full supply of filtered water. As it will not be adapted for drinking purposes for several days or until the distribution pipes have been thoroughly drained, the consumers have been advised to boil the water during this period. It is claimed that Major Gillette, of the Filtration Bureau, has, by inspection and prosecutions, reduced the amount of water wasted in this section of the city at least 5,000,000 gals. per day. The daily consumption is now 31,000,000 gals. The capacity of the filters is 39,000,000 gals.

A REPORT ON THE COURRIERES COAL MINE EXPLOSION.*

A joint report on the coal mine disaster which occurred at the Courrières Mines, Pas de Calais, France, March 10, 1906 (Eng. News, March 15, 1906, p. 307), has been submitted to the Home Secretary of England by Mr. H. Cunynghame, C. B., Assistant Under Secretary of the Home Department, and Mr. W. N. Atkinson, H. M., Inspector of Mines. After describing the Pas de Calais field, the report summarizes the history of the Courrières Company and notes the excellence of their working and general arrangements. The report then describes the method of opening and working the pits and the circumstances of the disaster, and notes the apparent cause of the explosion.

The general conclusion arrived at by Messrs. Cunynghame and Atkinson is that the explosion was an extensive and very formidable dust explosion, without, in all probability, the presence of any gas in the mine. Some of the reasons advanced for this view are as follows:

The mine was in great part worked with naked lights, as it was extremely free from fire-damp, and therefore it would be necessary to show that an explosive atmosphere existed and had suddenly spread over large areas of the mine in air currents coming from different sources. Also the explosion was particularly violent in many of the intake air pipes and air-ways, places where fire-damp would not probably be present. Again, neither the testimony of survivors of the explosion nor the position of the bodies of the victims indicated that the workmen had been alarmed before the explosion by the unexpected appearance of inflammable gas, or that anyone had seen the gas on a lamp or light. Regarding the idea that accumulations of fire-damp in old workings had contributed to the explosion, nothing was found after the explosion to substantiate it. On the other hand, as far as a judgment could be formed, all parts of the mine traversed by the explosion had contained much inflammable dust, charred or partially coked dust having been observed in all parts of the mine traversed by the explosion. Moreover, the explosion ceased at places where dust was either absent or of a very shaley nature. That the explosion had been caused by the fire discovered between March 6 and 7 in the return air-way through the old workings in the veine Cecile was not borne out by the observed facts. The fire had been completed enclosed by brick and cement walls the night before the explosion, and the investigation after the explosion showed that the walls, which had fallen, had been blown in towards the fire, This would not have been the case if the fire had caused the explosion.

In making the investigation as to cause and place of origin of the explosion, the inspectors found a blown-out shot, in the northwest portion of the veine Josephine, which they are inclined to think was the point of origin of the explosion, although no positive proof is obtainable that the blow-out shot occurred at the moment of the explosion. The position of the bodies of the men when found indicated that the shot had probably been accidentally exploded while being drilled out, with a subsequent explosion of coal dust.

The report, in part, is as follows:

A difference of opinion as to whether the explosion was initiated by a blow-out shot or by a local explosion of fire-damp originated by the shot or otherwise, does not in our view interfere with the main conclusion that it was through the agency of coal dust alone that the explosion was propagated throughout the mine. * * * Opinions may differ as to whether or not some fire-damp was present when the explosion originated. But the point that is of supreme importance is the consideration, that, however originated, an explosion can travel over the whole extent of a mine by the aid of coal dust alone, and without any gas. This we have no doubt whatever was the case at Courrières. This is a danger against which the use of safety lamps alone will not protect the miner, and it emphasizes the necessity for considering what means can be adopted for preventing or at least localizing and isolating explosions of coal dust. * * * The conclusion that the explosion was caused by a blown out shot of Favier explosive leads

*Condensed from the "Iron and Coal Trades Review."

to serious considerations with reference to the use in fiery or dusty mines of our permitted explosives. Points requiring attention appear to be (1) whether our present test for explosives requires to be altered, (2) the maximum charges which should be allowed, (3) the minimum length of stemming required, and (4) the method of dealing with shots which have missed fire. This explosion emphasizes the risk, now generally admitted to exist in dry and dusty coal mines, of great loss of life in case an explosion is initiated by any means. The only certain method of preventing such loss of life would seem to be to render the mines incapable of being the scene of widespread dust explosions by watering or otherwise preventing the accumulation of dry coal dust in the roads and workings.

The Courrières explosion extended through the workings of three pits, a fact which raises the question whether it is advantageous from the point of view of safety to connect the workings of different pits. The chief object of making the connections at Courrières was probably for the purposes of ventilation and haulage, and to obviate the necessity of sinking two shafts for each separate winding plant. At the same time we believe that the connections were regarded as conducive to safety by affording additional means of escape in case of accidents.

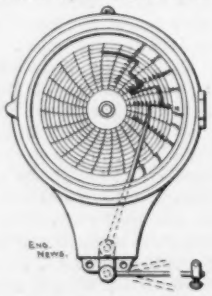
In the case of explosions the utility of extra shafts as means of escape will depend largely on whether the roads approaching them are traversed by the explosion or not, and this could be prevented so far as coal dust is concerned by keeping the roads clear of dust. At the same time roads connecting different areas of workings are liable to become channels for conveying after-damp into workings, which might not otherwise have been affected by an explosion; and they might also convey smoke in cases of fire. Where distant shafts are connected and are intended to be available as emergency exits, all the officials and a proportion of the workmen should be made acquainted with the roads leading to them, and direction boards should also be placed along the routes.

A MECHANICAL TIME RECORDER.

A mechanical time recorder such as shown herewith is convenient for recording the rate of motion and the position of sluice gates, turbine governors, gate valves and for recording the rise and fall of liquids in tanks, rivers, reservoirs and fore bays.

It consists of a circular chart revolved by clockwork at uniform speed, while the pen moves over the chart an amount proportional to the motion to be recorded. In order to provide suitable speeds for different requirements, clock movements can be supplied for a complete revolution of the chart once in 15 mins., 1 hr., 2 hrs., 3 hrs., 4 hrs., 6 hrs., 8 hrs., 10 hrs., 12 hrs., 24 hrs., or 7 days.

The pen arm is rigidly attached at its lower end to a shaft which is turned by a short arm projecting through a slot in the bottom of the case. The lever shown projecting to the right, is clamped to the short arm by a thumb-nut. This lever is adjustable and can be clamped to the arm at any convenient angle.



A Mechanical Time Recorder Useful in Many Engineering Industries.

The motion to be recorded after being reduced, if necessary, is imparted to the lever which in turn transmits it to the pen. The total scale on the chart is usually taken proportional to the total motion to be recorded. Reduced motion, if necessary, can easily be arranged by the aid of pulleys, levers or other reducing devices.

Fine adjustments can be made by applying the motion at the proper point along the lever, and to facilitate this a metal attachment is provided, which is adjustable on the lever arm, and secured in position by a thumb-nut.

The recorder is made by the Bristol Co., of Waterbury, Conn.

THE EXPLOSION OF A PIPE MOLD at the Youngstown Foundry & Machine Co.'s plant, Youngstown, Ohio, Nov. 12, killed one man and injured five others, three fatally. The men were pouring a 5-ft. pipe mold, with molten steel, when it burst, throwing the white-hot metal over the foundrymen.

STEAMSHIP TERMINAL WITH FIREPROOF WAREHOUSES; NEW ORLEANS TERMINAL RY.

The enormous financial loss and serious hindrance to traffic which resulted from the burning of the Stuyvesant Terminal Docks of the Illinois Central R. R. at New Orleans last year, called attention somewhat sharply to the dangers and objections of the common practice of using timber structures for the warehouses and other buildings at terminals of this class.

As pointed out at the time (in our issue of March 16, 1905), the value of the freight stored at such terminals is very great, and although elaborate fire-protection apparatus is usually installed this may prove insufficient to cope with a serious fire, as was the case at the Stuyvesant docks. With the increase in price of timber and the great development of methods of fireproof construction there would seem to be little reason for selecting the inflammable material in such cases, with the numerous objections and risks attendant upon its use. In the reconstruction of this terminal steel and reinforced-concrete construction were largely used.

Having this object lesson strongly in view, the New Orleans Terminal Co. has adopted fireproof construction for the sheds at its new deep-water shipping terminal at Chalmette, a few miles below the city of New Orleans, La. Figures 1 and 2 show a plan and cross section of the new terminal, but east of the sheds will be extensive freight yards, which are not shown on the plan. Tracks will also extend along the sides of the buildings and to the wharves on the river bank, but the exact track plan has not been definitely determined.

The terminal is located on filled or reclaimed land, and has a slip 300 ft. wide and 1,585 ft. long, with a depth of 30 ft. below extreme low water. The river front and the sides of the slip are protected by concrete retaining walls built upon timber grillage supported by piling driven to below the low-water line. Behind the grillage is a line of sheet piling, 34 ft. deep. On one side of the slip is a one-story freight house, 150×1,300 ft.; and on the other side is a two-story freight house 150 × 1,680 ft. There is also a grain elevator of 500,000 bushels capacity, connected by main and cross conveyors with a belt conveyor along the water side of the two-story freight house. The slip and buildings occupy a rectangular space enclosed by a levee, as shown on the plan. The height of this levee was fixed by the Government authorities, and this determined the floor level of the wharf and sheds, and consequently the grade of the tracks leading from the company's main line to the water front.

The two-story freight house, with its foundations and the concrete retaining wall, is shown in Fig. 3, which needs little explanation. The building is of steel frame construction, with the columns supported by concrete pedestals on pile clusters. The upper floor has a plate-girder floor system, while the roof framing is of steel

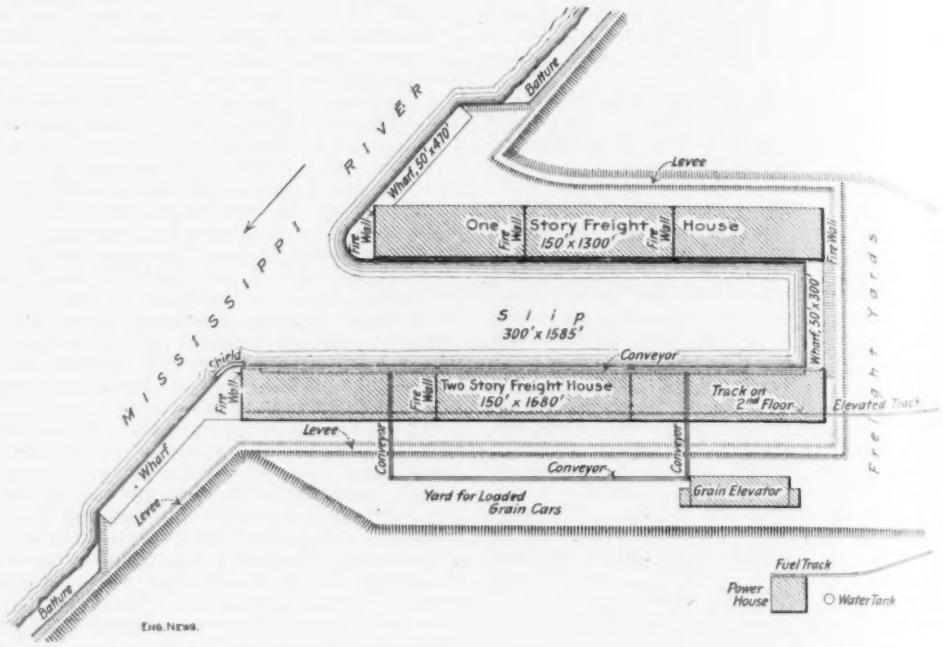


FIG. 1. PLAN OF THE CHALMETTE TERMINAL OF THE NEW ORLEANS TERMINAL CO.

I-beams. The dock face of the upper story is inclined inward to facilitate the handling of frieght by the cranes or derricks, and also to accommodate the grain conveyor along the edge of the roof. The sides of the pier are open on account of the character of the climate, but these can be closed with tarpaulin curtains when necessary. The house is divided into three compartments by fire walls, each of which has two openings fitted with automatic fire doors. The end walls and fire walls are carried about 6 ft. above the roof. The first floor is of concrete, 2 ins. thick, laid on 6 ins. of slag and finished with a 1½-in. concrete surface. The upper story has an 8-in. reinforced-concrete floor, and the roof is also of reinforced concrete, 3 ins. thick, covered with four-ply composition roofing. Inside the house (in the first panel, at the land side) is a railway track on the upper floor, connecting with an elevated track and incline in the yard.

An interesting feature of the foundation work is that along the river front the work of cutting off the piles and placing the timber grillages was done in a floating caisson. The piles were 50 to 75 ft. long, and were driven by floating pile drivers, followers being used to drive them to a depth of several feet beneath the water. The caison was of timber construction, about 72 × 33 ft. and 18 ft. high; the working chamber was 7 ft. 8 ins. high, and above this were the water-ballast compartments. It was placed between two barges having superstructures connected by trusses, and was suspended from these trusses by means of steel cables and tackle, the cables being led to the drums of a hoisting engine. When sunk to the average depth, with its lower edge 15 ft. below the water, it weighed about 800 tons.

The New Orleans Terminal Co. has a belt line about 30 miles in length, with city freight houses, and its Chalmette terminal will provide the rail

and water terminal facilities for the St. Louis & San Francisco Ry. System (including the Chicago, Rock Island & Pacific Ry.) and the Southern Ry. M. J. J. Hinckley is Chief Engineer of the St. Louis & San Francisco Ry. and the New Orleans Terminal Co., and Mr. F. G. Jonah is Resident Engineer of the latter company. The general contractors are James Stewart & Co., of New York, N. Y., and the foundation work along the river front has been done by The Foundation Co., of New York.

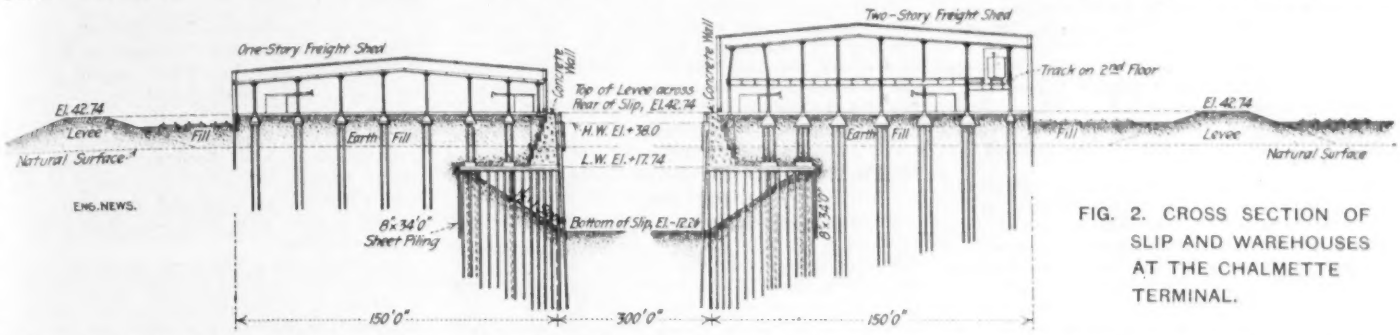


FIG. 2. CROSS SECTION OF SLIP AND WAREHOUSES AT THE CHALMETTE TERMINAL.

STREAM POLLUTION BY ACID-IRON WASTES; AND THE SEWAGE WORKS AT SHELBY, OHIO.

Stream pollution by acid-iron wastes from the mill of the Shelby Steel Tube Co. at Shelby, O., has been studied by Mr. Herman Stabler on behalf of the U. S. Geological Survey and the Ohio State Board of Health. A report on these studies has been published as Water Supply and Irrigation Paper No. 186 (U. S. Geological Survey, Washington, D. C.). The tube manufacturing plant at Shelby was put in operation in 1890. The wastes were for some years discharged directly into a small stream having about one-fifth to one-sixth the flow of Black Fork, into which the brook discharges not far below the mill. In October, 1902, a farmer owning 50 acres of bottom land on Black Fork, about four miles below the tube works, brought suit against the tube company for $2,500 damages for the alleged poisonous pollution of the stream and resulting damage to his land and cattle. The case was tried in June, 1903, and the plaintiff was awarded damages to the amount of $317, or $6.34 per acre. The statute of limitations confined the damages to a period of four years. The case went to the Supreme Court of Ohio, where the judgment of the lower court was affirmed.

Mr. Stabler is of the opinion that "a careful review of the testimony" during the trial showed that the mill wastes damaged the water for boiler purposes, ice supply and for stock, but actual injury to either stock or vegetation, he concludes, was uncertain.

The successful outcome of this suit led to a number of others, not all of which had been concluded at the time Mr. Stabler wrote.

In August, 1904, the tube company installed a plant for "disposing of the strong iron and sulphate liquors by converting them into crystal copperas." This plant was enlarged in June, 1905. Prior to the installation of the copperas recovering plant, the tube mills were connected with the city outfall sewer, and at present a part of the wastes passes through the sewer to the sewage works and thence to Black Fork, and a part goes directly into the brook and thence into Black Fork.

The Shelby sewage works are located about three miles north of the city, on a 25-acre tract owned by the city. An 18-in. gravity outfall sewer conveys from 250,000 to 300,000 gals. a day to the works. After passing through a ½-in. mesh wire screen the sewage goes alternately to one of two brick sludge basins, each 10 × 24 ft. × 6 ft. deep, and containing about 8,000 gals. One basin is used at a time for about three months, and then the sludge is pumped out and used as manure on the farm. From whichever basin is in use the partially clarified sewage passes to and through two shallow reservoirs arranged in series and having a combined capacity of about five days' sewage flow. The settled sewage is distributed by half-tile carriers over two filter beds of cinders and gravel, having a combined area of 25,000 sq. ft. Underdrains 6 ins. in diameter and 20 ft. c. to c. are placed in depressions and covered with 6 ins. of gravel which extends 3 or 4 ft. each side of the drains, the "sides of the depressions sloping to the drains." The filter beds proper are composed of ¼-in. cinders 18 ins. in depth. At first the filter beds received sewage directly from the sludge basins, but rapid clogging ensued and first the smaller and then the larger settling reservoirs were built. Mr. Stabler states that in February, 1905, he visited the sewage works and found that neither of the filter beds was in use; while in July, 1905, he found both of them flooded, with "every evidence of being badly clogged," sewage standing over them to a depth of 18 ins. In any case, he states, only about half the sewage passes through the beds, the rest finding its way to Black Fork by passing either through the banks forming the beds or through the leaky waste gates of the reservoirs. The whole plant shows "a superabundance of iron oxide."

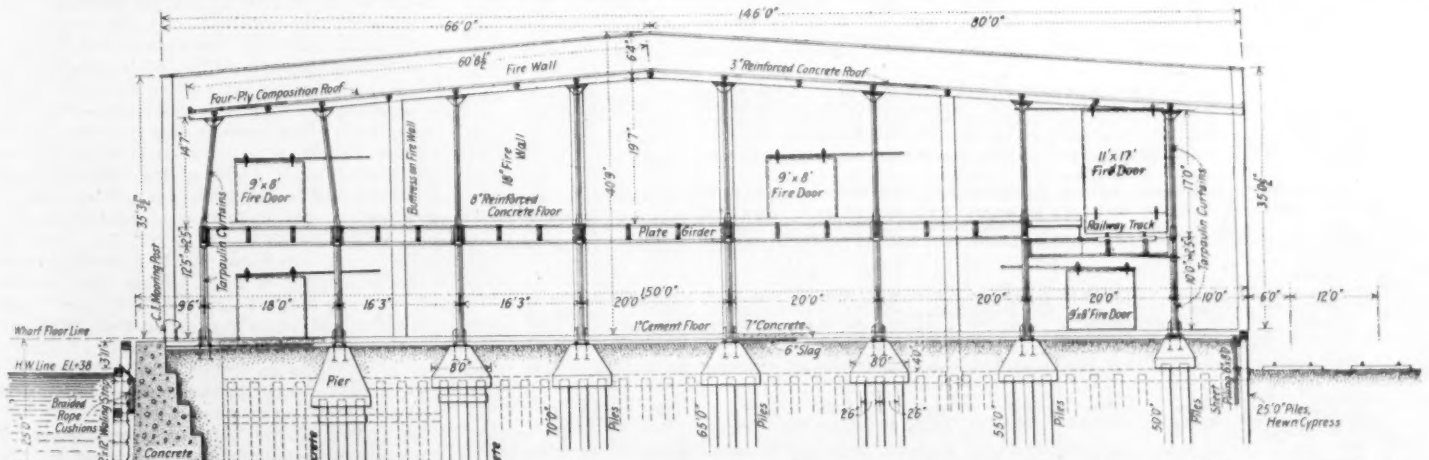


FIG. 3. TWO-STORY FREIGHT WAREHOUSE AT THE CHALMETTE TERMINAL OF THE NEW ORLEANS TERMINAL CO.

The filtrate is clear and free from suspended matter, but upon standing becomes turbid and receives a reddish cast from precipitation of iron. There is a lack of odor about the plant generally, which is no doubt due to the presence of a great quantity of ferrous sulphate in the sewage. The odor is noticeably greater in summer, however, than in winter. During the warm months a considerable septic action or gasification is apparent in the shallow reservoirs, more especially in the first or smaller one. Much sedimentation takes place in these ponds, and a thin scum, and at places a heavy crust, is formed upon the surface over a considerable area.

Mr. Stabler's paper contains detailed figures and text to show the effect of the acid-iron wastes upon the sewage and upon the operation of the filter beds. He also describes the plant installed by the tube company for the recovery of copperas from the pickling liquors. His final summary may be quoted as folows:

(1) Stream pollution by acid-iron wastes has been taking place at Shelby for about fifteen years, to the annoyance of riparian residents below the city for a distance of 12 miles. Complaints against this pollution (which may be defined as the entire waste of pickling liquors in which 1 lb. of 60° sulphuric acid is used to each 175 gals. per second of dry-weather flow in the stream) culminated in 1901 in a series of suits against the corporation responsible for the pollution, resulting in awards of damages in favor of residents along the stream living from three to seven miles below the point of pollution.

(2) Conditions along the stream were greatly bettered by the passage of the waste through the city sewage purification works (consisting of a sludge basin, shallow five-day sedimentation reservoirs, and shallow cinder and gravel filters), diluted by from 10 to 20 times its volume of a weak domestic sewage.

(3) The effect of the acid-iron sewage upon the sewage purification plant was to fill basin and reservoirs rapidly and thus decrease their efficiency, to destroy the working value of the filter beds in a comparatively short time, and to increase greatly the care requisite for the proper maintenance of the plant. Bacterial action was

seriously interfered with, the action of the early processes of the plant upon organic matter was diminished, and the effluent was rendered obnoxious by reason of a high content of iron sulphate. Odors about the plant and danger from pathogenic bacteria in the effluent were decreased by the acid-iron character of the sewage.

(4) The treatment of pickling waste in a plant for the production of crystal copperas, one-fifth of the acid used being so recovered, reduces the objectionable features of the sewage by about 60%, and is therefore of great value as a means of preventing stream pollution by such wastes.

The copperas-recovery process is the best method known for treatment of sulphuric-acid pickling liquors, is attended with a large per cent. of profit, and is applicable to pickling plants of all sizes. Such a plant, properly arranged, will entirely obviate stream pollution by "waste pickle."

(5) Rinse water from the pickling process, not including leakage and splashage from the pickling tubs, can, in general, be discharged into the sewerage system of a town or into a stream without detrimental consequences, but it will produce a discoloration of the water unless the dilution is very great. Although such waste does not seriously affect the uses of a stream, it may be rendered entirely unobjectionable at a trifling cost by precipitation with lime or ammonia, and such treatment is advised.

(6) Of the acid used in pickling at Shelby, only 21.7% is recovered in the copperas product. Of the remaining 78.3%, 8.8% is lost in the copperas plant, 65.8% is lost in the pickling process, and 3.7% passes into the city sewerage system as rinse water. Of the 74.6% not definitely accounted for by the officials of the company, a part passes off as fumes from the pickling tubs; some is known to be discharged directly into the streams as washings from tubs, and the remainder apparently enters the stream direct or by way of the sewers, presumably as leakage.

This "lost" acid is the cause of the present pollution at Shelby. By designing the plant so that this waste may be recovered as copperas, stream pollution can be practically obviated and the economic value of the plant greatly enhanced.

(7) The present pollution at Shelby makes the stream waters red and turbid, seriously damages them for general use, and renders them deleterious to fish life for a total of not more than two miles. No other damaging effects were found except an increase in the permanent hardness of the water, by which it becomes less suitable for boiler and for domestic use.

POOR'S STATISTICS OF UNITED STATES RAILWAYS FOR 1905.

From advance sheets of "Poor's Manual" for 1906 we reproduce the accompanying interesting tables of statistics of the railways of the United States. Table I. shows for each year from 1898 to 1905, inclusive, the principal figures as to mileage, rolling stock, financial balance sheet and results of operations. The detailed figures are valuable for reference. The most interesting feature of the table is the rapid growth and development which has taken place in every department of the railway service during the seven years which have elapsed since the end of the financial depression of 1892 to 1897.

During these seven years nearly 27,000 miles of new railway has been built and over 28,000 miles of track has been laid in extension of sidings, third and fourth trackage and sidings. The rolling stock has been enlarged by the addition of 13,000 locomotives, about 8,000 passenger equipment cars and nearly 500,000 freight cars. The capital account has been enlarged by the issue of about $1,200,000,000 in stock and about $[illegible]-000,000 in bonds.

An enormous increase has taken place in traffic. Passenger mileage, notwithstanding the diversion of suburban and interurban traffic to electric lines, has nearly doubled and the ton-mileage of freight moved has grown from 115 billion ton-miles in 1898 to 187 billion ton-miles in 1905. The gross earnings have been swelled by some 860 million dollars, but nearly two-thirds of this has been absorbed by increased operating expenses, leaving a gain of a little less than $300,000,000 in net earnings.

Notwithstanding the large increase in bonded debt, the reduction in interest rates (due largely to refunding of outstanding bonds bearing high rates of interest) makes the payment of bond interest only $10,000,000 greater in 1905 than in 1898. On the other hand, the dividends to stockholders have more than doubled, the increase being nearly $100,000,000, while only $95,000,000 was paid to railway stockholders in 1898.

Tables II., III. and IV. are of historic interest as showing the rate of growth of the railway system in different parts of the country. It will be seen by Table II. that the number of locomotives doubled in the 21 years from 1884 to 1905. Actually, the increase in locomotive power proceeded at a more rapid rate, for coincident with the increase in number there was a great increase in the average size and in the ton-miles and passenger-miles produced per annum per locomotive. The annual increase in mileage, shown in Table III., must be considered in connection with the movement for enlargement of terminals, and yards and additions to tracks and passing sidings, which have absorbed almost or quite as much capital in the last few years as the new construction proper. Table IV. gives in small compass a record of the progress of railway building in each State since the middle of the last century.

Tables V. and VI. show in detail 13 years' growth in passenger traffic and in freight traffic. Particularly interesting are the figures of growth in passenger receipts per train-mile and per mile of railroad. The average fare per mile has remained nearly stationary and the growth has been due to larger traffic giving more passengers in a train and larger passenger earnings per mile of railroad. The reduction in receipts per ton-mile, shown in Table VI., is not due to any reduction in freight rates, but to a steady increase in the proportion of bulk freights, coal, iron ore, etc., and in the average length of haul. Most noteworthy of all is the astounding increase in the average freight train-load from 170 tons in 1893 to 335 tons in 1905. This is doubtless the most radical change in the conditions of railway operation that has ever taken place.

Table VII. shows thirteen years' change in financial results, and makes more clear the reasons for the increased value of railroad stocks already pointed out.

TABLE I.—STATEMENT SHOWING THE MILEAGE, EQUIPMENT, LIABILITIES AND ASSETS, TRAFFIC OPERATIONS, EARNINGS, INTEREST AND DIVIDEND PAYMENTS, ETC., ETC., OF ALL THE STEAM RAILROADS, 1898 TO 1905, INCLUSIVE.

	1905	1904	1903	1902	1901	1900	1899	1898
	Miles.	*Miles.*	*Miles.*	*Miles.*	*Miles.*	*Miles.*	*Miles.*	*Miles.*
Mileage of Railroads.	213,634.18	211,074.39	206,885.99	199,684.64	196,886.90	192,161.93	187,781.08	184,894.33
2d Track, Sidings, etc.	88,707.57	82,863.03	79,376.03	75,150.75	70,105.45	65,691.29	62,581.72	60,344.54
Total Track.....	301,331.75	293,937.42	286,262.02	274,835.39	265,992.35	257,853.22	250,362.80	245,238.87
Steel Rails in Track..	290,529.24	282,229.35	271,012.70	257,437.11	246,811.60	238,464.13	228,975.54	220,803.87
Iron Rails in Track...	10,802.51	11,708.07	15,249.32	17,398.28	19,180.75	19,389.09	21,387.26	24,435.00
	No.	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*
Locomotives..... ...	49,616	47,844	44,529	41,626	39,729	38,065	37,945	36,746
Cars—Passenger	30,777	29,205	28,648	27,364	27,144	26,786	26,184	25,844
Bag., Mail, etc.	10,552	10,417	10,182	9,726	8,667	8,209	8,121	8,049
Freight.....	1,757,105	1,691,427	1,624,150	1,503,949	1,409,472	1,350,258	1,328,084	1,284,807
Total Revenue Cars	1,798,434	1,731,049	1,662,980	1,541,039	1,445,283	1,385,253	1,362,389	1,318,700
Liabilities:	$	$	$	$	$	$	$	$
Capital Stock.....	6,741,956,925	6,447,045,374	6,255,907,335	6,078,290,596	5,978,796,349	5,804,346,250	5,742,181,181	5,581,522,856
Bonded Debt*.....	7,821,243,106	7,462,091,455	6,722,216,517	6,465,290,839	6,035,469,741	5,758,592,754	5,644,858,027	5,635,363,594
Unfunded Debt	201,978,773	172,619,537	448,199,448	310,345,867	312,225,536	328,963,335	305,777,858	368,182,584
Current Accounts ..	620,720,096	516,404,178	648,434,976	479,957,935	456,798,012	422,262,823	377,497,070	383,682,168
Sinking and other Funds.....	182,853,229	203,962,204	115,201,683	140,679,814	143,670,983	114,800,960	95,013,713	†
Total Liabilities..	15,568,752,029	14,802,122,748	14,189,959,959	13,474,565,051	12,926,960,521	12,428,966,022	12,165,327,849	11,968,751,204
Excess of Assets....	650,821,816	620,750,567	572,851,585	479,542,767	381,068,511	339,944,815	291,946,163	316,616,498
Total.....	16,219,573,845	15,422,873,315	14,862,111,544	13,954,107,818	13,308,029,032	12,768,910,837	12,457,274,012	12,285,367,702
Assets:								
Cost of RR. & Equip.	12,143,997,551	11,664,191,194	11,253,311,285	10,865,683,376	10,717,752,155	10,484,430,907	10,254,251,458	10,256,275,385
Other Investments....	2,935,276,877	2,712,445,967	2,653,851,625	2,345,515,940	1,976,548,412	1,766,498,090	1,708,507,108	1,594,565,979
Sundry Assets.....	367,454,847	408,808,136	552,036,399	455,053,773	390,112,441	328,994,626	325,725,460	265,264,972
Current Accounts....	772,844,570	637,328,078	422,912,235	287,854,729	223,616,024	188,992,213	168,789,986	169,261,166
Total Assets	16,219,573,845	15,422,873,315	14,862,111,544	13,954,107,818	13,308,029,032	12,768,910,837	12,457,274,012	12,285,367,702
	Miles.	*Miles.*	*Miles.*	*Miles.*	*Miles.*	*Miles.*	*Miles.*	*Miles.*
Miles of RR. Operated	215,506.92	211,835.21	206,237.12	197,887.36	194,974.96	191,861.96	186,590.38	184,532.61
Rev. Train Mileage:								
Passenger.....	467,270,447	446,800,386	431,314,116	403,213,178	391,543,708	373,226,581	355,106,853	344,761,142
Freight	559,434,683	543,447,633	546,380,595	508,210,140	505,468,619	513,667,388	534,391,846	542,834,509
Mixed.....	26,715,494	28,069,594	22,288,855	22,990,130	20,812,965	20,702,172	20,996,771	17,424,581
Total.....	1,053,420,624	1,018,407,543	999,983,566	934,413,448	917,825,312	907,596,141	910,495,450	905,010,232
Passengers Carried...	745,446,641	719,173,676	696,949,925	655,130,236	609,485,790	584,695,935	537,977,301	514,982,868
Passenger Mileage ...	23,906,430,668	22,108,484,478	20,895,606,421	19,706,908,785	17,789,689,925	16,313,264,471	14,859,541,965	13,672,497,064
Tons Freight Moved .	1,435,321,748	1,295,537,441	1,306,628,858	1,137,193,253	1,084,066,451	1,071,431,919	975,789,941	912,975,833
Freight Mileage.....	187,375,621,537	172,627,299,384	171,292,196,079	156,622,241,662	148,959,305,492	141,162,109,413	126,991,705,110	114,566,173,191
	$	$	$	$	$	$	$	$
Traffic Earn'gs—Pass.	486,420,902	456,342,380	429,705,287	396,513,412	360,702,686	331,402,816	297,559,712	272,589,591
Freight	1,478,167,246	1,377,281,206	1,344,150,719	1,197,212,452	1,126,267,652	1,052,835,811	922,436,314	868,994,526
Miscellaneous....	147,609,622	144,015,127	135,001,880	127,089,096	125,478,488	117,456,751	116,100,353	108,044,607
Total.....	2,112,197,770	1,977,638,713	1,908,857,886	1,720,814,900	1,612,448,826	1,501,695,378	1,336,096,379	1,249,558,724
Net Earnings	635,464,488	639,240,027	592,508,512	560,026,277	520,294,727	483,247,526	423,941,689	389,666,474
Other Receipts.....	80,927,659	81,357,891	89,485,484	77,663,483	68,368,814	67,772,934	55,619,405	104,536,904
Total Avail. Revenue.	706,392,147	720,597,918	681,993,996	637,689,760	588,663,541	551,020,460	479,561,094	494,203,378
Payments:								
Interest on Bonds....	247,155,897	242,992,755	230,426,707	222,614,909	215,191,176	214,199,502	208,957,209	237,133,099
Other Interest.....	12,956,346	13,533,529	8,680,451	9,733,560	7,327,334	6,315,028	6,071,451	5,069,290
Dividends on Stock..	193,753,869	188,386,093	164,549,147	151,019,537	132,162,935	119,288,879	88,076,393	94,937,526
Miscellaneous.....	59,856,679	54,557,670	61,336,614	57,408,351	36,235,397	46,153,433	36,569,447	35,681,080
Rentals—Interest....	31,716,773	32,807,445	38,675,121	40,622,542	39,127,204	30,248,304	30,221,704	62,740,145
Dividends...	22,314,099	23,254,134	26,125,208	27,154,215	24,724,348	21,054,774	20,955,859	.....
Miscellan...	22,206,880	18,120,306	21,320,600	19,970,212	22,586,953	21,200,651	20,010,276	.....
Taxes.....	54,553,630	54,325,856	.....	.....	.....	.....	.....	.....
Total Payments..	644,516,133	627,977,878	560,113,908	528,523,326	477,355,347	458,460,571	410,862,339	435,561,140
Surplus.....	121,876,014	92,620,040	121,880,088	109,166,434	111,308,194	92,559,889	68,698,755	58,642,238

* Including, in 1905 and 1904, real estate mortgages, equipment trust obligations, etc., previously included in item "Unfunded debt." † Previous to 1899, included with Profit and Loss.

Year.	Locomotives.	Revenue Cars.			
		Passenger.	Baggage, Mail and Express.	Freight.	Total.
1884.....	10,911	13,947	4,976	648,295	667,218
1885.....	21,809	14,394	5,564	730,435	750,393
1886.....	23,405	16,250	5,848	778,663	800,741
1887.....	24,353	16,644	5,911	798,399	820,954
1888.....	25,662	16,497	6,044	805,517	828,058
1889.....	26,108	18,365	6,305	845,912	870,582
1890.....	27,373	19,330	6,554	950,889	976,773
1891.....	29,006	20,247	6,827	1,005,108	1,032,182
1892.....	30,566	21,471	7,053	1,061,141	1,089,665
1893.....	31,813	21,664	7,253	1,051,952	1,080,869
1894.....	33,563	23,088	7,308	1,163,679	1,194,130
1895.....	34,626	24,604	7,850	1,177,113	1,209,567
1896.....	36,118	27,179	7,977	1,206,444	1,241,600
1897.....	36,304	26,357	7,921	1,228,781	1,263,059
1898.....	36,610	26,479	7,991	1,220,798	1,255,268
1899.....	36,398	24,940	7,980	1,245,640	1,278,560
1900.....	38,410	25,854	8,180	1,284,972	1,318,906
1901.....	39,745	25,944	8,049	1,284,807	1,318,700
1902.....	41,626	27,364	9,726	1,503,949	1,541,039
1903.....	44,529	28,648	10,182	1,624,150	1,662,980
1904.....	47,844	29,205	10,417	1,691,427	1,731,049
1905.....	49,616	30,777	10,552	1,757,105	1,798,434

ANNUAL CONVENTION OF THE ROADMASTERS AND MAINTENANCE-OF-WAY ASSOCIATION.

This association appears to have taken on a new lease of life, and promises to again assume an important position among railway organizations, as indicated by the proceedings of its annual convention, held at the Sherman House, Chicago, on Nov 13, 14 and 15. For the past few years the standing of the association has materially diminished, and it reached a very low point at the Niagara Falls meeting last year, the attendance being very small and the technical part of the proceedings of little importance. This year the attendance was good, about 75 members being present, exclusive of guests and visitors, and although the reports and papers were few in number the discussions were brisk and interesting. This was in large measure due to the energy of the President, Mr. Charles Buhrer (L. S. & M. S. Ry.).

The opening meeting on the morning of Nov 13 was devoted to addresses of welcome, the reading of minutes and other general business. At the afternoon session there was presented the report of the Committee on "The Best Method of Maintaining the Track for the Tonnage and Speed of To-Day," the discussion of which occupied almost the entire time of two sessions. An abstract of this is given below, but it is evident that the committee was not well informed as to the history of rail design or the problems of manufacture, since the report recommended a return to the old wide-base form of rail. The recommendation was for a height of 5 ins. and a base of 6 ins., although this would mean that the wide thin flanges would be cold long before the head had cooled to the temperature at which it should receive its finishing passes. A base of moderate width resting on steel tie-plates is the better arrangement.

TRACK MAINTENANCE FOR MODERN CONDITIONS OF TONNAGE AND SPEED.

FOUNDATION AND DRAINAGE.—More care should be taken to prepare the foundation for roadbed, and in water-bearing clay or quicksand the grading should allow for at least 3 or 4 ft. of good ballast under the ties. The committee has observed cases where good surface, prepared with months of hard work and large sums of money, has been destroyed during heavy rainstorms. This could have been avoided by building a more permanent roadbed, the extra cost of which would save the high expense of continually surfacing low and uneven places. Permanent roadbeds should be 20 to 22 ft. wide for single track, and 34 to 35 ft. for double track on high banks; and the same width in cuts to make room for good side ditches. The wide roadbeds on banks will prevent ties and ballast from going down the slopes when material is unloaded, and much time is often lost in recovering such material, while much of the material is also lost.

Good drainage is absolutely necessary for good permanent track, and should be provided for by open ditches and tile drains, as conditions may require. For the latter, nothing smaller than 4-in. tile should be used, and larger sizes are preferable. Where the roadbed is in soft water-bearing material, cross drains should be provided. The ditching on roads that have a great many cuts causes expensive maintenance, and care

TABLE IV.—STATEMENT SHOWING MILEAGE OF RAILROAD BY STATES AND GROUPS ON 31ST OF DECEMBER EACH YEAR, AT VARIOUS PERIODS SINCE 1850 (EXCLUDING ALL ELEVATED CITY PASSENGER RAILWAYS).

States and Groups of States.	1850	1860	1870	1880	1890	1900	1902	1903	1904	1905
New England:										
Maine	245	472	786	1,005	1,377.47	1,916.94	2,000.03	2,004.79	2,029.89	2,091.12
New Hampshire	467	661	786	1,015	1,142.25	1,188.15	1,191.95	1,191.42	1,191.77	1,191.77
Vermont	200	554	614	914	991.42	1,045.28	1,052.31	1,057.84	1,056.96	1,063.90
Massachusetts	1,035	1,354	1,480	1,915	2,098.69	2,111.42	2,114.94	2,117.41	2,110.81	2,104.87
Rhode Island	68	108	136	210	217.43	209.20	209.20	209.84	209.84	209.84
Connecticut	402	601	742	923	1,006.64	1,025.40	1,025.90	1,025.90	1,020.12	1,020.12
Group I., Total	2,507	3,660	4,494	5,982	6,831.90	7,501.46	7,594.43	7,607.20	7,619.39	7,680.92
Middle Atlantic:										
New York	1,361	2,682	3,928	5,957	7,684.41	8,085.00	8,137.49	8,190.98	8,167.21	8,212.12
New Jersey	206	560	1,125	1,684	2,109.06	2,242.93	2,258.14	2,943.56	2,269.64	2,269.61
Pennsylvania	1,240	2,598	4,656	6,191	8,636.99	10,334.06	10,508.45	10,784.54	10,991.97	11,161.45
Delaware	30	127	197	275	314.95	348.62	339.36	338.63	334.86	333.60
Maryland	259	386	671	1,040	1,270.04	1,339.34	1,370.98	1,363.98	1,364.45	1,406.81
Dist. of Columbia					30.66	24.88	24.87	24.70	24.70	24.70
Group II., Total	3,105	6,353	10,577	15,147	20,038.11	22,394.85	22,619.29	22,950.25	22,149.83	23,408.29
Central Northern:										
Ohio	575	2,946	3,538	5,792	7,980.49	8,885.46	8,971.76	9,023.61	9,163.97	9,243.26
Michigan	342	779	1,638	3,938	7,108.48	8,092.46	8,249.63	8,459.65	8,467.76	8,521.46
Indiana	228	2,163	3,177	4,373	6,109.19	6,873.19	6,809.83	6,854.73	6,863.03	7,046.90
Illinois	111	2,790	4,823	7,851	10,165.67	11,048.40	11,208.07	11,308.38	11,743.10	11,959.09
Wisconsin	30	905	1,525	3,155	5,612.62	6,536.87	6,695.43	6,921.40	7,014.78	7,188.18
Group III., Total	1,376	9,583	14,701	25,109	36,976.45	41,136.38	41,934.72	42,741.79	43,251.64	43,958.89
South Atlantic:										
Virginia	384	1,379	1,486	1,893	3,259.65	3,789.58	3,870.53	3,933.09	3,933.67	3,982.11
West Virginia	97	352	397	691	1,433.30	2,473.34	2,604.07	2,566.49	2,860.82	2,966.05
North Carolina	283	937	1,178	1,466	3,126.17	3,737.53	3,793.93	3,790.73	3,913.66	4,015.58
South Carolina	289	973	1,139	1,427	2,289.15	2,919.31	3,011.44	3,113.46	3,148.54	3,184.19
Georgia	643	1,420	1,945	2,459	4,900.80	5,739.91	6,109.73	6,108.21	6,296.97	6,516.61
Florida	21	402	446	518	2,489.52	3,355.71	3,430.74	3,469.92	3,585.53	3,635.36
Group IV., Total	1,717	5,463	6,481	8,474	17,300.59	21,905.38	22,820.44	22,980.90	23,589.39	24,179.90
Gulf & Miss. Valley:										
Alabama	183	743	1,157	1,843	3,422.90	4,197.22	4,348.72	4,442.69	4,590.80	4,708.37
Mississippi	75	862	960	1,127	2,470.85	2,954.27	3,009.15	3,156.56	3,367.23	3,541.04
Tennessee		1,253	1,402	1,943	2,737.38	3,164.91	3,273.98	3,252.19	3,464.92	3,606.88
Kentucky	78	534	1,017	1,530	2,942.38	3,068.75	3,177.74	3,195.31	3,261.56	3,355.07
Louisiana	80	335	450	652	1,789.85	2,801.27	3,005.01	3,419.38	3,593.66	3,784.17
Group V., Total	416	3,727	5,106	6,995	13,342.66	16,211.42	16,969.50	17,567.13	18,297.36	19,025.73
Southwestern:										
Missouri		817	2,000	3,995	6,142.02	6,887.44	7,148.03	7,316.62	7,797.18	7,859.57
Arkansas		38	258	659	2,203.44	3,108.56	3,453.48	3,651.28	3,948.54	4,165.73
Texas		307	711	3,944	8,709.85	9,991.69	10,307.16	11,308.05	11,614.13	11,949.02
Kansas				1,501	3,400	8,824.11	8,774.08	8,803.16	8,810.50	8,841.09	8,874.58
Colorado				137	1,570	4,291.11	4,549.68	4,756.47	4,982.44	4,980.35	5,093.20
New Mexico					756	1,288.77	1,770.77	2,340.91	2,450.08	2,441.93	2,596.64
Indian Territory					289	1,260.65	1,487.60	2,109.50	2,220.02	2,585.69	2,686.47
Oklahoma Terri'y.							919.87	1,669.43	2,350.52	2,635.64	2,686.19
Group VI., Total			1,169	4,635	14,065	32,887.95	37,529.60	41,350.17	43,068.45	44,852.05	46,061.39
Northwestern:										
Iowa		655	2,683	5,400	8,416.13	8,870.25	9,537.53	9,668.07	9,695.73	9,693.10
Minnesota			1,092	3,151	5,545.35	6,996.89	7,396.96	7,499.49	7,641.82	7,947.10
Nebraska			705	1,953	5,407.47	5,695.36	5,777.56	5,779.99	5,777.59	5,881.35
North Dakota			65	1,225	2,116.49	2,810.63	3,071.14	3,171.55	3,211.81	3,734.69
South Dakota					2,810.41	2,961.86	3,027.74	3,045.39	3,068.56	3,182.04
Wyoming			459	512	1,062.98	1,241.96	1,238.37	1,238.61	1,243.65	1,280.62
Montana				106	2,185.57	3,039.32	3,324.27	3,361.51	3,367.78	3,396.49
Group VII., Total		655	5,004	12,347	27,294.56	32,105.56	33,173.57	33,813.44	34,206.74	35,157.33
Pacific:										
Washington				289	2,012.05	2,988.44	3,094.55	3,305.21	3,292.48	3,301.05
Oregon			159	508	1,429.97	1,670.90	1,711.94	1,730.43	1,730.43	1,681.67
California		23	925	2,195	4,849.73	6,566.56	6,772.59	6,868.80	6,908.37	6,971.60
Nevada			585	798	993.18	920.37	920.53	956.89	1,186.89	1,282.22
Idaho				206	946.11	1,319.41	1,433.91	1,437.09	1,485.42	1,495.30
Arizona				849	1,094.81	1,515.94	1,680.49	1,715.80	1,786.81	1,830.97
Utah			257	849	1,295.49	1,681.09	1,611.40	1,681.44	1,743.49	1,807.84
Group VIII., Total		23	1,934	5,128	12,621.34	15,465.54	16,205.41	16,720.66	17,227.52	17,868.85
Recapitulation by Groups of States.										
New England Group	2,507	3,660	4,494	5,982	6,831.90	7,501.46	7,594.43	7,607.20	7,619.39	7,680.92
Middle Group	3,105	6,353	10,577	15,147	20,038.11	22,394.85	22,619.29	22,950.25	22,149.83	23,408.29
Central North'n Group	1,376	9,583	14,701	25,109	36,976.45	41,136.38	41,934.72	42,741.79	43,251.64	43,958.89
South Atlantic Group	1,717	5,463	6,481	8,474	17,300.59	21,905.38	22,820.44	22,980.90	23,589.39	24,179.90
Gulf & Miss. Valley Gr.	416	3,727	5,106	6,995	13,342.66	16,211.42	16,969.50	17,567.13	18,297.36	19,025.73
Southwestern Group		1,162	4,625	14,065	32,887.95	37,529.60	41,350.17	43,068.45	44,852.05	46,061.39
Northwestern Group		655	5,004	12,347	27,294.56	32,105.56	33,173.57	33,813.44	34,206.74	35,157.33
Pacific Group		23	1,934	5,128	12,621.34	15,465.54	16,205.41	16,720.66	17,227.52	17,868.85
United States	9,621	30,626	53,922	93,247	166,708.36	194,262.22	202,667.53	207,354.35	212,394.14	217,341.09

TABLE III.—STATEMENT SHOWING MILES OF RAILROAD FROM 1830 TO THE CLOSE OF 1905, INCLUSIVE.

Year.	Miles in Operation.	Annual Increase of Mileage.	Year.	Miles in Operation.	Annual Increase of Mileage.	Year.	Miles in Operation.	Annual Increase of Mileage.
1830	23	...	1856	22,016	3,642	1880	114,677	11,569
1831	95	72	1857	24,503	2,487	1881	121,422	6,745
1832	229	134	1858	26,968	2,465	1882	125,345	3,923
1833	380	151	1859	28,789	1,821	1883	128,320	2,975
1834	633	253	1860	30,626	1,837	1884	136,338	8,018
1835	1,098	465	1861	31,286	660	1887	149,314	12,976
1835	1,273	175	1862	32,120	834	1888	156,114	6,900
1837	1,497	224	1863	33,170	1,050	1889	161,276	5,162
1838	1,913	416	1864	33,908	738	1890	166,708	5,437
1839	3,202	289	1865	35,085	1,177	1891	170,729	4,036
1840	2,818	516	1866	36,801	1,716	1892	175,170	4,441
1841	3,535	717	1867	39,050	2,349	1893	177,516	2,346
1842	4,026	491	1868	42,329	2,979	1894	179,415	1,899
1843	4,185	159	1869	46,844	4,615	1895	181,115	1,700
1844	4,377	192	1870	52,922	6,078	1896	182,769	1,654
1845	4,633	256	1871	60,301	7,379	1897	184,591	1,822
1846	4,930	297	1872	66,171	5,870	1898	186,810	2,219
1847	5,598	668	1873	70,268	4,097	1899	190,818	4,008
1848	5,996	398	1874	72,585	2,117	1900	194,262	3,444
1849	7,365	1,369	1875	74,006	1,711	1901	198,743	4,481
1850	9,021	1,656	1876	76,808	2,712	1902	202,938	4,195
1851	10,982	1,961	1877	79,082	2,274	1903	207,335	4,397
1852	12,908	1,926	1878	81,747	2,665	1904	212,394	5,059
1853	15,360	2,452	1879	86,556	4,809	1905	217,341	4,947
1854	16,720	1,360	1880	93,232	6,706			
1855	18,374	1,654	1881	103,108	9,846			

NOTE.—The "annual increase in mileage" usually represents the net increase within the year named. Above will be found a detailed statement of railroad construction for the four years 1902-1905, and similar statements for preceding years will be found in previous issues of the MANUAL. The total mileage of all lines in the country at the end of 1904, as shown by the revised statements presented herewith, was 212,394.14 miles; construction during the year, as per construction table above, 5,050.22 miles, and miscellaneous increases, resulting from remeasurements, etc., aggregating 67.45 miles—total, 217,513.81, from which deduct sundry lines reported abandoned, transferred to side track, and equipped with electricity, aggregating 170.79, leaving mileage, Dec. 31, 1905, 217,341.02 miles.

TABLE V.—STATISTICS OF PASSENGER TRAFFIC FOR THIRTEEN YEARS, 1893-1905. STATEMENT SHOWING THE LENGTH OF ROAD OPERATED, PASSENGER STATISTICS, EARNINGS, ETC., ETC., OF ALL THE RAILROADS IN THE UNITED STATES FROM 1893 TO 1905, INCLUSIVE.

Years.	Length of Rlds. in Operation.	Miles Run by Passenger Trains.	Passenger Traffic. Pass'ng'rs Carried.	Passenger Traffic. Passenger Movement.	Passenger Earnings. Gross Amount.	Ave. Receipts p. Pass. p. Mile.	Av. Rec. per Pass.	Av. Rec. p. Pass. Train Mile.	Av. Rec. p. Mile of RR.	Ave. No. of Miles of Railroad.	Ave. No. of Miles per Pass. Train Mile.	Average Distance Travelled p. Passenger.
	Miles.	*Miles.*	*No.*	*Miles.*	$	*Cents.*	*Cents.*	*Cents.*	$	*No.*	*Miles.*	*Miles.*
1893	173,361	238,551,808	597,056,539	14,979,947,426	310,442,870	2.072	52.00	91.70	1,791	3,444	44.35	25.09
1894	176,221	325,981,869	569,666,316	13,900,531,636	275,252,192	2.025	48.34	84.47	1,563	3,253	41.72	23.97
1895	179,154	328,184,596	589,756,259	12,600,082,551	260,929,741	2.069	49.25	79.99	1,456	2,957	39.66	23.86
1896	180,891	337,641,115	595,130,756	13,054,940,943	265,313,268	2.032	49.58	78.53	1,467	2,956	38.66	24.40
1897	180,821	342,484,408	504,106,305	12,494,958,000	258,557,986	2.069	50.50	74.04	1,403	2,791	36.49	24.78
1898	183,216	344,761,142	514,982,988	13,073,497,664	272,580,391	1.994	52.93	79.07	1,486	2,811	39.06	25.38
1899	185,330	355,106,833	537,977,301	14,950,541,965	307,559,719	2.002	55.31	83.79	1,604	2,899	41.54	27.63
1900	190,994	378,326,561	564,695,965	16,313,964,471	331,402,816	2.031	58.67	86.79	1,738	3,066	43.92	27.90
1901	198,825	391,543,709	600,486,790	17,789,669,925	360,732,686	2.028	60.07	92.13	1,814	3,096	43.48	29.63
1902	198,648	408,313,178	655,120,326	19,706,908,785	396,513,412	2.012	60.52	96.94	1,956	3,211	44.07	30.08
1903	202,910	430,378,158	696,908,994	20,995,573,953	428,713,109	2.042	61.52	99.61	2,102	3,418	45.56	30.69
1904	210,354	446,690,386	719,173,678	22,108,464,473	455,068,675	2.058	63.28	101.85	2,163	3,513	46.46	30.74
1905	213,635	467,270,447	745,446,641	23,906,480,668	484,929,076	2.028	65.05	103.77	2,269	3,499	51.16	32.06

TABLE VI.—STATEMENT SHOWING THE LENGTH OF THE ROAD OPERATED, FREIGHT STATISTICS, EARNINGS, ETC., ETC., OF ALL THE RAILROADS IN THE UNITED STATES FROM 1893 TO 1905, INCLUSIVE.

Years.	Length of Rlds. in Operation.	Miles Run by Freight Trains.	Freight Traffic. Freight Carried.	Freight Traffic. Freight Movement.	Freight Earnings. Gross Amount.	Av. Receipts p. Ton p. Mile.	Ave. Rec. per Ton.	Av. Rec. p. Fre't Train Mile.	Av. Rec. per Mile of RR.	Average No. of Tons per Mile of Railroad.	Ave. No. of Tons. Miles p. Freight Train Mile.	Average Haul per Ton.
	Miles.	*Miles.*	*Tons.*	*Miles.*	$	*Cents.*	*Cents.*	*Cents.*	$	*Tons.*	*Miles.*	*Miles.*
1893	173,361	531,340,754	757,484,459	90,593,097,290	808,494,666	0.893	106.74	152.16	4,663	4,369	170.49	119.55
1894	176,221	475,789,866	674,714,747	82,219,900,498	700,477,409	0.852	103.80	147.23	3,975	3,869	172.81	121.88
1895	179,154	491,410,830	755,799,883	88,967,770,901	743,784,451	0.836	98.40	151.36	4,151	4,368	180.23	115.56
1896	180,891	497,348,296	773,988,716	93,895,853,634	770,494,013	0.821	99.55	154.94	4,259	4,378	188.81	121.32
1897	181,065	500,336,373	788,365,448	97,848,569,150	780,851,936	0.797	98.99	157.77	4,310	4,364	195.56	124.12
1898	184,117	542,824,509	912,973,873	114,586,173,191	868,994,586	0.758	95.18	160.09	4,719	4,959	211.06	125.50
1899	186,294	534,391,846	975,789,941	126,991,705,110	922,436,814	0.726	94.53	172.61	4,953	5,240	237.64	130.04
1900	191,455	513,667,398	1,071,631,919	141,162,109,413	1,052,835,811	0.746	98.30	204.95	5,498	5,396	274.79	131.80
1901	194,455	508,468,619	1,094,086,451	148,950,308,492	1,106,267,059	0.756	101.59	222.82	5,792	5,575	294.70	137.41
1902	197,261	508,210,149	1,192,135,510	156,694,186,094	1,197,312,452	0.764	100.43	235.57	6,085	6,041	308.19	131.38
1903	204,668	545,098,459	1,299,084,081	171,280,810,698	1,277,706,616	0.791	102.93	245.35	6,246	6,250	314.98	131.79
1904	211,393	542,084,087	1,273,077,475	172,613,087,474	1,270,396,438	0.736	107.63	253.78	6,497	6,098	318.42	135.58
1905	214,595	559,434,663	1,433,281,748	187,375,621,537	1,489,518,157	0.794	103.93	262.67	6,840	6,681	334.90	130.45

TABLE VII.—GROSS AND NET EARNINGS, INTEREST, AND DIVIDENDS FOR THIRTEEN YEARS, 1893-1905.

Statement showing gross and net earnings, available revenue, interest and dividend payments, etc., of all the steam surface railroads in the United States, from 1893 to 1905, inclusive.

Years.	Gross Earnings.	Net Earnings.	Total Available Revenue.	Payments from Available Revenue. Int. on Bds.	Payments from Available Revenue. Dividends.	Earnings Per Mile of RR. Gross.	Earnings Per Mile of RR. Net.	Expenses to Earnings.	Interest paid—on total Bonded Debt.	Dividends paid—on total Share Capital.
	$	$	$	$	$	$	$	p. c.	p. c.	p. c.
1893	1,227,106,026	358,648,918	469,515,755	227,677,739	94,226,815	6,663	2,009	70.29	4.31	1.88
1894	1,066,943,356	317,727,290	413,914,333	224,708,912	83,478,689	6,054	1,803	70.22	4.19	1.66
1895	1,099,395,437	335,196,424	436,964,569	230,698,134	81,085,774	6,097	1,804	70.41	4.34	1.58
1896	1,125,632,025	332,768,979	437,701,890	241,387,730	81,598,154	6,223	1,840	70.43	4.45	1.52
1897	1,133,866,696	342,792,050	440,423,354	254,454,578	83,690,040	6,236	1,884	69.74	4.94	1.49
1898	1,249,558,734	389,666,474	494,908,378	237,133,099	94,937,586	6,771	2,111	68.16	4.21	1.70
1899	1,326,098,379	429,941,689	479,561,004	239,178,913	109,082,252	7,161	2,372	68.27	4.34	1.90
1900	1,501,695,978	468,947,598	561,030,460	244,447,206	140,943,653	7,896	2,519	68.93	4.94	2.48
1901	1,619,448,988	480,934,737	568,668,541	254,315,280	156,897,283	8,270	2,503	67.73	4.81	2.93
1902	1,780,614,900	560,088,277	638,960,559	263,227,451	178,200,778	8,696	2,850	67.45	4.09	2.93
1903	1,908,527,286	592,626,512	681,968,986	275,101,599	190,674,415	9,201	2,857	68.96	4.13	3.00
1904	1,977,696,713	599,940,097	730,597,918	275,800,200	211,640,227	9,348	2,839	67.93	3.98	3.14
1905	2,113,197,770	693,464,468	798,282,147	270,315,290	208,675,622	9,643	3,139	67.54	3.65	3.03

should be taken to provide the proper slope for the material, to keep it from washing or sliding. All cuts should have good surface ditches at the top of the slopes. In cuts, tile drains should be laid on each side, about 1 ft. from the ends of the ties; on double track a drain should be laid between the tracks and cross drains provided every 500 ft. The tile should be at least 2 ft. below the top of the ballast and covered with 1 ft. of porous cinders.

BALLAST.—On account of the increase in tonnage and speed in past years, this committee would recommend broken or crushed stone durable enough to resist the disintegrating influences of the weather and climate. It should be hard enough to prevent pulverizing under the treatment to which it is subjected, and stone should be selected that will break in angular pieces when crushed. The maximum size of ballast should not exceed that of pieces which will pass through screens having 1½ to 2 in.-holes. The minimum size should not pass through a screen having ¼-in. holes. For new roadbed the depth should not be less than 18 ins., but on old roadbed, where gravel or cinder ballast has been used to a depth of 10 or 12 ins., an additional 6 ins. of stone ballast will give good results. This class of ballast will be free from dust, which is a very essential point. Gravel ballast, unless it is washed and the fine dust removed, will be more or less dusty; much gravel contains clay, and during wet weather causes track to get loose and out of surface. Gravel ballast cannot be worked successfully while wet, but stone ballast can be worked in either wet or dry weather. While stone ballast is harder to work than gravel ballast, it will maintain surface and line better and make a more permanent roadbed.

TIES.—The committee recommends ties 7 × 9 ins. and 8 ft. 6 ins. long. The proper spacing should be 18 ins. c. to c. for ties 8 ins. wide, or 20 ins. for 9-in. ties; shoulder ties at joints should be 16 or 18 ins. c. to c.

RAILS.—For lines of heavy traffic the rails should be of 90 to 100 lbs. per yd. in weight and 30 to 33 ft. in length. Such rails will be heavy enough to handle and unload from cars and lay in the track. A height of 5 ins. is enough, on account of the danger of spreading track under heavy engines and fast trains. The committee recommends a rail with a 6-in. base and 5 ins. in height, as safe and proper to be used with the present rolling stock. The wide base would materially lessen the tendency of the rail to cut into the ties. It will give a larger and a more solid bearing surface, and with this design of rail there should be less spreading of track. [The fallacy of this argument has been noted above.—Editor.]

RENEWING TIES.—If a general renewal is to be made, the best results can be obtained by lifting the track sufficiently high to remove the old ties without disturbing the roadbed, and permit the new ties to be carefully bedded. In this way the general surface of the track will not be disturbed. Where there are only from three to five ties to be removed in one rail length, and the general surface is good, it will not be proper to raise the track, but the decayed ties should be dug out and the new ties placed on the old foundation, as existing conditions will permit. On roads with very heavy and fast traffic all track should be resurfaced and carefully tamped with tamping bars or picks on the same day the ties are put in, for the reason that if the roadbed is dug deeper in some places than in others the tendency will be to settle unevenly, and result in rough and unsafe track for fast trains.

EASEMENT CURVES.—These should be used as follows: A, for speeds not exceeding 30 miles per hour, on all curves exceeding 2°; for speeds not exceeding 60 miles an hour, on all curves exceeding 1°; for higher speeds, on all curves over 60 minutes. The length of the easement curve should correspond with the distance in which the superelevation is run out. For ordinary practice, a chord length equivalent to 100 ft. for each degree of variation in curvature is recommended, or 150 ft. for very high speed roads; where the distance between curves (or other reasons) will not allow this, a chord length of 25 to 30 ft. may be used.

Any form of transition is satisfactory which gradually changes the degree of curvature, and in which the length of chord per degree of variation can readily be changed to suit each particular case, the essential point being that the length of the easement curve shall be the same as the distance in which the elevation of the outer rail is raised from zero to full elevation. Any transition curve of the type of the Searles, Crandall, Holbrook, Talbot or the cubic parabola, which is susceptible of being run in by deflection or offset, is good for this purpose.

In the discussion as to tile drainage, Mr. Burke (C., M. & St. P. Ry.) advocated laying the tile on planks to prevent uneven settlement, and Mr. Thompson (A., T. & S. F. Ry.) stated that he lays the tile in a deep trench with a fall of 3 ins. in 100 ft. Mr. Houghton (L. S. & M. S. Ry.) spoke of the successful use of bell-and-socket vitrified drain tile in wet ground, and while some speakers objected to the use of vitrified tile others considered that porous tile gradually becomes nonporous so that water enters only at the joints. As to stone ballast, opinions varied as to the limits of size, 2 ins. being considered too large and ¼-in. too small. Some speakers had used unscreened stone, but while one approved of it, other found it unsatisfactory, as tending to hold water, and to pack almost as hard as concrete. It was voted that the minimum size should be ½-in. On the subject of ties, a rather surprising strength of opinion in favor of a length of 9 ft. was developed. In regard to tie renewals, Mr. McCurdy (C. St. P. M. & O. Ry.) thought the best practice was to avoid patchwork renewals; where possible, all ties on a certain length of the section should be renewed each year, the renewals on the remainder of the section being limited to such individual ties as absolutely required to be taken out. Other speakers, however, thought this would be impracticable, owing to the very varying life of ties and to the fact that the track would not be in first-class condition where only a few renewals had been made. The committee's recommendation that ballast should be sloped down from a point under the rail was strongly objected to, the opinion being that under modern conditions it is necessary to fill in level with the top of the tie and form a shoulder (even as wide as 4 ft.) outside, in order to hold the track in line. Mr. Emery (C. & N. W. Ry.) and Mr. Jones (C. B. & Q. Ry.) took this view as the result of experience with heavy traffic, and it was voted to qualify the recommendation as made in the report.

After the conclusion of this discussion at the morning session on Nov. 14, a paper on "The Construction and Maintenance of Track in Tunnels" was read by Mr. E. E. R. Tratman (Associate Editor of Engineering News). This was largely compiled from articles published in our issue of Sept. 20.

At the afternoon meeting, a committee report on "Tie Plates" was presented. This was very brief and covered ground that has already been covered many times, and the discussion was largely a presentation of rather indefinite opinions and preferences as to different makes of tie-plates. There was considerable diffidence, however, in mentioning the names of the plates, owing to the fact that all are patented articles. Some speakers advocated the use of a wide-base rail and the elimination of tie-plates, but there is little to be said in favor of such a change, as has already been noted. A topical discussion on the methods of obtaining and keeping competent men for track foremen was then taken up. The two points forcibly brought out were that there is already great difficulty in finding men competent to fill vacancies, and that the remedy lies in the payment of wages more in accordance with the degree of skill and intelligence required in the maintenance of modern railway track. An interesting feature of this session was that the exhibitors of track material and supplies were given the privilege of the floor, each being allowed five minutes in which to speak of his exhibit or specialties. A list of the exhibitors is given elsewhere.

The election of officers resulted as follows: President, C. H. Cornell (C. & N. W. Ry.); Vice-Presidents, T. W. Guffy (A. T. & S. F. Ry.) and John Kennedy (B. & O. Ry.); Secretary and Treasurer, W. E. Emery (C. & N. W. Ry.), West Chicago, Ill. The next meeting will be held at Chicago in November, 1907.

A CAR-FERRY STEAMER, "The Ontario No. 1," to run across Lake Ontario from Toronto to the New York shore, is to be launched from the yards of the Canadian Shipbuilding Co., at Toronto, on Dec. 1. The vessel cost $370,000, carries 24 loaded freight cars and has staterooms for 100 passengers. She is 320 ft. long, 56 ft. wide, and when loaded will draw 15 ft. Her speed will be 15 miles an hour; she is equipped with twin screws and triple expansion engines. The vessel is owned by and will be operated in connection with the Grand Trunk Ry., and a chief purpose of its construction is said to be for the carriage of coal across Lake Ontario.

THE VALUE OF HIGH STEAM PRESSURES IN LOCOMOTIVE SERVICE.

At the November meeting of the Western Railway Club, in Chicago, there was presented a paper by Prof. W. F. M. Goss, of Purdue University, on the value of high steam pressures in locomotive boilers, being an abstract of a report made by him on investigations made at the instance of the Carnegie Institution. The tests were made at pressures of 120 to 240 lbs. (which range below and above the pressures common in locomotive service), and were made on the engine in the University testing laboratory, making the equivalent of 14,072 miles. Without going into the details of the tests we give below the conclusions presented by Prof. Goss as a summary of the results:

1. Tests have been made to determine the performance of a typical locomotive when operating under a variety of conditions with reference to speed, power and steam pressure. The results of 100 such tests have been made of record.

2. The results apply only to practice involving simple expansion locomotives using saturated steam. They cover only such conditions as may be maintained with wide open throttle. Pressures specified are to be accepted as running pressures. They are not necessarily those at which safety valves open.

3. The steam consumption and coal consumption under normal conditions of running have been established as follows:

Boiler Pressure lbs.	Steam per HP.-Hour lbs.	Coal per HP.-Hour lbs.
120	29.1	3.84
140	27.7	3.67
160	26.6	3.53
180	26.0	3.46
200	25.5	3.40
220	25.1	3.35
240	24.7	3.31

4. The results show that the higher the pressure, the smaller the possible gain resulting from a given increment of pressure. An increase of pressure from 160 lbs. to 200 lbs. results in a saving of 1.1 lbs. of steam per HP.-hour, while a similar change from 200 lbs. to 240 lbs. improves the performance only to the extent of 0.8-lb. per HP.-hour.

5. An increase of pressure from 160 lbs. to 200 lbs. results in a saving of 0.13-lb. of coal per HP.-hour, while a similar change from 200 lbs to 240 lbs. results in a saving of but 0.09-lb.

6. Under service conditions, the improvement in performance with increase of pressure will depend upon the degree of perfection attending the maintenance of the locomotive. The values quoted in the preceding paragraphs assume a high order of maintenance. If this is lacking, it may easily happen that the saving which is anticipated through the adoption of higher pressures will entirely disappear.

7. The difficulties to be met in the maintenance both of boiler and cylinders increase with increase of pressure.

8. The results supply an accurate measure by which to determine the advantage of increasing the capacity of a boiler. For the development of a given power, any increase in boiler capacity brings its return in improved performance without adding to the cost of maintenance, or opening any new avenues for incidental losses. As a means of improvement, it is more certain than that which is offered by increase of pressure.

9. As a scale of pressure is ascended, an opportunity to further increase the weight of a locomotive should in many cases find expression in the design of a boiler of increased capacity rather than in one for higher pressures.

10. Assuming 180 lbs. pressure to have been accepted as standard, and assuming the maintenance to be of the highest order, it will be found good practice to utilize any allowable increase in weight by providing a larger boiler rather than by providing a stronger boiler to permit higher pressures.

11. Wherever the maintenance is not of the highest order, the standard running pressures should be below 180 lbs.

12. Wherever the water which must be used in boilers contains foaming or scale-making admixtures, best results are likely to be secured by fixing the pressure below the limit of 180 lbs.

13. A simple locomotive using saturated steam will render good and efficient service when the running pressure is as low as 160 lbs.; under most favorable conditions, no argument is to be found in the economical performance of a machine which can justify the use of pressures greater than 200 lbs.

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Some months ago a correspondent in these columns ventured to question the advantage of the modern shop-drawing and templet system of fabricating steel work in comparison with the old-time system—or lack of system—called "laying-out," for want of a better name. Another letter on the same subject appears in our present issue and we think it an appropriate time to suggest to engineers the question whether there is not such a thing as going too far in our reliance on the drafting room and the blueprint frame in manufacturing establishments.

Of course, we do not for a moment doubt that the modern methods of mechanical drafting and the design of a machine or a structure in the drafting room instead of in the shop have been of great benefit. In fact, modern manufacturing establishments could not be operated under the old cut-and-try methods that prevailed a half-century ago.

Admitting all this, we want to inquire whether there is not at times today such a thing as making too many drawings, leaving too little to the judgment and common sense of the men in the shop, or in the field, becoming a little too slavish in our adherence to red tape and routine. Everybody has heard the Civil War story of the bridge foreman in the Engineer Corps, who, when the General in command inquired whether the plans were ready for a bridge which was to be constructed as preliminary to an important movement, replied: "I dunno whether the pictur's done, General, but the bridge is ready."

The story has often been used to throw undeserved ridicule on the methods of the engineer; but it does contain a lesson well worth consideration. In the valuable series of papers by Mr. John C. Moses which has drawn out the correspondence above noted, it was stated that the drawing room and templet shop may at times spend as much money on a piece of structural work as the actual cost of making it in the shop. Is there no method of reducing this large expense? Can we not in some way simplify our drawing room methods, and reduce the cost of getting ready to do the actual work of construction?

We believe the problem is worth the serious attention of engineers and of those having responsible charge of a great variety of industries. Of course, in those branches of manufacturing where repetition work is done and a great number of duplicate pieces are turned out, the drawing room expenditures are comparatively small. Here it often becomes well worth while to expend a large amount of time and money on a single drawing, since the saving made or improvement effected may involve a hundred or a thousand or even a larger number of pieces. In building the larger and heavier classes of machinery, however, such as locomotives, large engines and machine tools, and in all structural work and shipbuilding, each piece of construction stands by itself and the problem is how to keep down the expense of detail design.

The work of a bridge or boiler shop or of a shipyard may in fact be likened to that of a tailor. The iron and steel plates and shapes correspond to the lengths of cloth. Each has to be cut up into proper shapes and each has to be sewn together into the desired form, the cloth with needle and thread, the steel plates and shapes with punches or drills and rivets. Every keen student of shipbuilding operations is impressed with the great amount of time and expense devoted to the mere location of the stitches in the steel hull. It is confessedly one chief reason why England can far underbid all other nations in the construction of tramp steamers, that, in the great English yards these boats are built by the half dozen or dozen from one set of drawings and templets with a consequent great saving in cost of construction.

Another subject, not too far afield to be here referred to, is the advantage of studying design problems in the shop and the field as well as over the drawing board. Such matters as brake gear, electric wiring, steam or water piping, track layouts, etc., can oftentimes be better studied out in the place where they are to be erected than over the drawing board. It was always done that way in the olden times. The engineers of a former generation made few drawings, and a good share of those they did make were rough sketches. A finished drawing was a rare and costly article and was made for record rather than for use in construction.

As we said above, great progress has been made since these early days; but it is possible that some things about these earlier methods of doing work may be worth bringing back into our practice at the present day. We shall be glad to hear from our readers who can offer results of experience in these matters.

An esteemed contemporary in the railway field—esteemed by us too highly for us to quote its name in this connection—has published the following in its account of the Atlantic City drawbridge disaster:

> The occurrence of a derailment like this will give rise to the query why the interlocking of the signals was not made to depend not only on the bridge being in place, but also on the rails being secure. To this the Pennsylvania officers, having tried both methods, reply that they have deliberately employed the watchman instead of adopting the additional mechanical complication. The chance of a watchman's introducing danger by making a wrong move or by omitting any move, is believed to be less than the chance of a disarrangement of mechanical parts which shall escape detection and lead to the display of a false clear signal, as has been known to occur.

We wonder what particular Pennsylvania officers were guilty of this piece of alleged wisdom. If any of them desire to assume responsibility for it, we will publish their names with pleasure.

The "additional mechanical complication" (which sounds to the uninformed reader like something at least as elaborate as a Waltham watch) consists of nothing in the world but *four pairs of rail clips*, fastening the rails on the draw-span to the rail lifting channels.

Will our still esteemed contemporary please find out from the oracle which it quotes above exactly when and where and how the "disarrangement of mechanical parts" (these four rail clips) occurred, which led to the "display of the false clear signal?"

If it is actually better to leave the lifting rails loose on the lifting channels, and anybody has any facts which go to prove this, for pity's sake let the facts be known. What we want and what the engineers responsible for safe drawbridge design want is to know what the best and safest practice is.

The trouble with such a paragraph as that quoted above from a reputable technical journal, is that it tends to confuse and mislead. If it is really better to depend on the watchmen, than on "mechanical complication," then the Pennsylvania ought to dispense with its interlocking signaling plant at the drawbridge entirely, and, if at that drawbridge, at every other one on the line, and while they are about it the complicated block signal apparatus might as well go, too.

We strongly suspect that our contemporary has been imposed upon, and that the Pennsylvania has *not* deliberately decided to omit the clips from rail-lifts on its drawbridges of the Atlantic City type. If, however, by any possibility this has been the case, we sincerely hope that long before this a hurry-order for rail clips for all the draw-spans on the system has been sent out from the Broad St. Station.

The backwardness of health departments in protecting city milk supplies from infection by typhoid fever is illustrated by the fact that the city of Denver, Colo., has only within a few weeks passed an ordinance designed to compel dairymen to sterilize their utensils before using them. What other health protective features the ordinance contains, if any, we cannot state, but it should strike at the root of the matter by prohibiting the use of impure water for washing milk pails, cans or bottles. In fact, every city should exclude from delivery or sale within its limits any milk from a dairy farm whose water supply is not above suspicion. At Denver the water company has been bitterly attacked, of late, on account of the prevalence of typhoid in the city, it being alleged that the responsibility for the disease rested on the company. Without presuming to pass on this contention we do emphatically assert that the time has come for health departments and the public generally to look well to other causes than water for the spread of typhoid. To this end, water departments must, in many cities, insist on the reorganization of health departments and on ample appropriations for health board work. The readers of Engineering News could aid greatly in these reforms in their respective localities by lending their influence and intelligence to all movements that will increase the efficiency of general health protective work. One of the most important means to this end is the appointment of well-trained, well-paid, permanent health officers, who give their whole time and energy to their work.

MORE CONCERNING GOVERNMENT INVESTIGATION OF RAILWAY ACCIDENTS.

A valued correspondent, who has read our plea in last week's issue for investigation of railway accidents by experts in the employ of the Interstate Commerce Commission, writes us as follows:

> I regret that I cannot agree with you in what you say in your last issue at the bottom of the first column on page 507, as to the worthlessness of the New York and Massachusetts Railroad Commissions.
>
> I should put the matter in quite another way, namely, that had New Jersey had a Railroad Commission, it is probable that the accident at Atlantic City would not have happened. It is morally certain that at least one other railroad accident (the crushing out of the lives of some twenty school children in Newark on the D. L. & W. R. R.) a couple of years ago, would not have happened.

We by no means intended to give the impression that the New York or the Massachusetts Railroad Commission are worthless. Each of these bodies, and particularly the latter, has a great amount of very valuable work to its credit. It is true, nevertheless, that at times, particularly in New York, appointments to the Commission have been made for political reasons rather than because of familiarity with practical railroad operation or because of the ability of the candidates in other respects for public service.

The most important point, however, is that no single State has within its borders enough serious railway accidents to employ continuously a competent expert in their investigation. The result is that when a State commission does set out to investigate an accident it is obliged to take such investigators as it can obtain for the especial occasion.

In order that a person may make a success in studying railway accidents and interpreting their lessons, experience is essential, and experience not alone in railway operation, but in the study of such accidents.

We can best make this clear by an illustration: Thirty or forty years ago the cotton manufacturing industry was laboring under a heavy burden from high insurance rates, made necessary by the frequent and disastrous fires. The situation led to the formation of mutual insurance companies by the manufacturers and to the creation of a new art of fire protection engineering, aimed to prevent fires from occurring in the cotton factories. The results have been well-nigh miraculous in transforming one of the most dangerous risks in the whole insurance field into one of the safest.

There is need to-day, we maintain, for just such a systematic study of railway accidents, with a view to their prevention, as was made many years ago of cotton-mill fires. It will be said, of course, that railway officers know how to prevent accidents just as well as any experts can tell them. Just so it was said forty years ago by the owners and superintendents of cotton mills that they knew how to prevent fires as well as any theorist with new-fangled ideas could tell them. Fortunately, there were owners and managers wise enough to admit their ignorance. With a beginning once made, it was promptly shown that the mill managers were so busy with problems of production that they had not studied the problems of safe mill construction and equipment for fire prevention. So in the case of railway officers, particularly those in the operating department. It is only the exceptional few railway operating officers who are really at all competent to pass judgment on a large proportion of the questions concerning safety in appliances and methods.

We remarked last week that it would pay, and pay well, any large railway company to employ its own expert for the investigation of accidents; yet we have no expectation of seeing any such radical innovation put into practice. A good illustration of the reason why is furnished by the disastrous butting collision of Nov. 12 on the Baltimore & Ohio, where nearly fifty passengers were killed, many of them being burned to death in the fire following the wreck. The cause, if newspaper accounts are correct, is an old and disgraceful story in American railroading. A train, side-tracked to let another train in the opposite direction pass, pulled out on the main line after the first section had gone by, because the train crew was not notified or else forgot that a second section was following close behind the first.

If an expert were set to report on this accident, he would have to point out not only the failures of the particular employees which caused the wreck, but also the criminal negligence of the men higher up, who continue to operate a single-track railway carrying such a heavy traffic as that of the Baltimore & Ohio main line to Chicago under the old train dispatcher system, instead of introducing the block system or the train staff system.

No; we do not expect to see any expert study of railway accidents initiated by the railway companies. The work must be undertaken by the National Government, or it will not be undertaken at all.

In saying these things, however, we do not by any means wish to reflect upon the ability and good faith of the great mass of operating railway officials, and particularly of those in charge of the technical departments of railway work, the engineers of bridges, of maintenance of way, of signaling, etc. The large majority of these men are doing the best they can with what they have to do with; obeying orders and working under conditions where real initiative is not in demand. The opposition to technical investigations of railway accidents will not come from these men, but from those higher up, who are using the great railway systems as counters in a vast game of speculation, and who are too much engrossed in their game to care for the real advancement of railway practice.

LETTERS TO THE EDITOR.

Wanted: A Durable Mile-Post.

Sir: I desire to erect mile posts and signs for junctions of county roads and would be glad to hear from some of your subscribers their opinion of the best material for the purpose.

Heretofore stone mile posts have been used, but vandals have broken and so disfigured many of them as to make them useless. Have iron mile posts and signs been used to any extent and with what success? Any suggestions along this line will be appreciated by

Yours truly,

J. T. Bullen, County Engr.

Montgomery, Ala., Nov. 13, 1906.

Short Cuts in Earthwork Computations.

Sir: In your issue of Oct. 18 I notice another short cut in earthwork computation.

Having obtained the number of cubic feet in a cut or fill would it not be more simple to divide by 9, then by 3, and obtain the correct result? On having the two end areas x and y of a given cross-section the following formulas can be easily reduced. I find them to be easily handled, and rapid.

$\frac{x+y}{1.08}$ for 50-ft. stations; $\frac{(x+y)\,2}{1.08}$ for 100-ft. stations, which reduces itself into $\frac{(x+y)\,2\,s}{108.0}$ where x and y are the end areas in square feet, and s is the length of station in feet.

I would like to see something in your columns as to the best method for vertical curves.

Yours truly,

H. G. Cowling.

Camden, Wash., Nov. 3, 1906.

Sheet Piling in an Earth Dam.

Sir: A client of mine owns an earth dam about 18 ft. in height by 300 ft. in length. The center portion, 80 ft. long, was recently carried away by a freshet and I am building a concrete spillway to fill up the opening. The old portion has timbers and sheeting on the up-stream face against which the stream has washed in clay sediment, forming a bank in front of the sheeting, which does not come up to the full height of the sheeting, leaving about 5 ft. of vertical sheeting exposed to the pressure of the ice in the reservoir.

I wish to strengthen this bank on the up-stream side by the addition of filling, and a covering of riprap, and claim the sheeting is a source of weakness and should be removed. Certain influences in the company oppose me, and I wish to know if any of your readers can quote actual instances of such sheeting causing trouble.

I claim the water will follow down along the sheeting and separate the bank into two units, the one up-stream from the sheeting, and the one down-stream from it, and that the bank would be better able to resist water pressure or ice thrust without this sheeting.

Yours truly, P.

—— Ontario, Nov. 13, 1906.

Competent Engineering Design and Supervision for Reinforced Concrete Construction.

Sir: I see in your issue of Nov. 15 a letter from Mr. Gunvald Aus, in which the necessity of employing competent engineers to design and supervise construction of concrete-steel work is urged. I am heartily in accord with the spirit of that letter and hope that the subject will be taken up and strongly urged by engineers in general. One point in concrete-steel work is that too much care cannot be taken in mixing and placing the concrete. As your correspondent stated, the design of the work is too often left to the contractor and he may or may not be competent to calculate the strength required, but more often his object is to get the work to stand a test long enough to get his final payment. In order to save expense, the contractor often cuts down the iron to such an extent that a tensile strain is brought upon the concrete, and still oftener the ends of the iron rods are not secured to the main girders in such a manner as to transmit the load to them.

It appears to me to be a mistake to rely upon concrete for columns and beams except in small buildings with light loading, and I would only use it for floors and fireproofing. Properly designed and carefully constructed concrete-steel floors are superior to any other form, in my opinion, but without careful design and constant supervision during construction they are the worst kind of death trap.

Yours truly,

James Ritchie, M. Am. Soc. C. E.

Chamber of Commerce Building, Cleveland, Ohio, Nov. 16, 1906.

A Remarkable Record for Latimer Rerailing Bridge Guards on the Hoosac Tunnel R. R.

Sir: The communication of Mr. H. B. Potter on rerailing devices, in your issue of Nov. 15, calls to mind an experience of mine on the same road mentioned by him, namely, the former Hoosac Tunnel R. R. Some twenty years ago I had occasion to examine a bridge on this road about three miles east of Shelbourne Falls, Mass., and walked from that station to the bridge. About a mile from the station there were marks of a recent derailment, evidently of a car in a freight train. The car had ploughed along over the roadbed, sometimes near the ends of the ties and sometimes hugging the rails, cutting the ties badly and bruising and bending the splice and joint bolts. It ran this way for perhaps a mile when it reached a bridge protected by Latimer guards and was put back on the track. A few rods beyond the bridge it again left the rails and ran in the same manner as before until it reached a second bridge, perhaps half a mile further on, and was rerailed once more. After crossing this bridge it once more left the rails, but evidently by this time it was discovered and taken care of as it did not run far. The two bridges crossed were both deck structures and had they not been provided with Latimer guards the car would have stood a good chance of dropping off the ends of the ties on both bridges. I believe all of these Latimer guards which were formerly on this road have been removed, though just why, considering what duty they had done, I am unable to conceive. I believe an instance of a derailed car being put back on the track at two successive bridges within a short distance of each other is unique.

Chas. F. Stowell.

Albany, N. Y., Nov. 17, 1906.

The Washington Typhoid Situation and Other Causes Than Water Supplies for the Spread of Typhoid Fever.

Sir: The writer was much interested in the series of articles published in Engineering News of Nov. 8 regarding the Washington filtration plant, and particularly in those pertaining to the unique position held by the filter in its relation to the amount of typhoid fever in the city.

One phase of the subject touched upon in your editorial seems worthy of further emphasis. Namely, the beneficial effect which the present agitation, concerning the lack of a reduction in the typhoid fever death rate, since the filter has been in operation, may have in calling attention to certain factors other than those related to polluted water supplies.

The mind is apt to overestimate, for a time, the value of widely exploited facts or ideas to the neglect of others equally important but not so much in evidence.

While the writer thoroughly realizes the necessity of rigid sanitary protection for our water supplies and feels that the serious conditions in many of our cities fully justifies the furor which has been created in favor of filtration; he nevertheless believes that there is sometimes a tendency, in cases of typhoid fever epidemics, to condemn the water supply offhand. This is well illustrated by the contents of a paragraph noticed some time ago in one of the daily papers, and commented upon editorially in the Engineering News for Sept. 13, 1906: There occurred some time ago, in a western town, an outbreak of typhoid fever, the cause of which was a matter of serious concern to the good town officials, until the perplexing problem was solved (?) by the discovery by some curious person that a colony of birds were nesting under the roof of the water-works stand-pipe. The writer advances no opinions as to the probability of the infection of the water supply from any such source, but simply cites the instance as an example of the alacrity with which the water is sometimes convicted on the slightest provocation.

Washington has a model filtration plant, the existence of which will doubtless be fully justified by means of future data. The success of this filter located in a city resembling the more southern municipalities whose racial and climatic characteristics tend to produce conditions favorable to the spread of disease should but emphasize the need of other sanitary regulations equally as important as those relating to water supply.

Yours truly, W. L. Butcher.

211 Lake View Ave., Cambridge, Mass., Nov. 10, 1906.

Adjusting the Survey Notes of Three Contiguous Lots.

Sir: The problem presented in your issue of Nov. 1, 1906, p. 463, under the above head, has difficulties which no fast rule will solve, for there are too many "unknown quantities" about which the article gives no information. Adjusting the notes of old surveys where errors are found is a difficult and uncertain task, especially where a resurvey cannot be had. However, from an inspection of the sketch of the three lots I was struck with one fact: while the south, east and west sides are mostly straight lines, the north side is a broken line; perhaps along the

north side there had been obstructions of some kind rendering the survey there more difficult and uncertain. This would then also apply to the lines closing upon the north side.

An adjustment by means of changes in the angles is more complicated in this case than changes in the sides; therefore I suggest the following: Reducing the length of course 3-4 of lot I 1.65 ft. reduces the error in latitude to — 0.046 and in departure to — 0.166 ft. Reducing the length of course 4-5 of lot II 13.96 ft. reduces the error in latitude to — 0.140 and in departure to + 0.004 ft. Reducing the length of course 5-8 of lot III 6.6 ft. reduces the error in latitude to + 0.105 and in departure to + 1.045. This last error in departure is still large and can be made smaller only by a combination of changes. Of course it is not certain that the simplest changes are the right ones, but it seems that the changes indicated have more in their favor than any which can be made so far as the meager information in the article referred to indicates.

But a better way to arrive at the proper adjustments of the errors is to study the conditions on the ground and make such changes in the notes as will fit in the best, taking into consideration any explanatory remarks given in the deeds transferring the lots, and also in deeds to adjoining lots, and giving due heed to credible verbal evidence and existing monuments.

Yours truly, "Westerner."

Nov. 8, 1906.

[To clear up the doubt raised in the above letter about the north line of the three lots in question, we made inquiry of the correspondent who submitted the problem. He informs us that the broken north line is the line of an old road or lane, still existing. He says, further, that the land is easy sloping ground, with apparently no special obstacles or difficulties at any one point to make the old measurements less reliable on one side than on another.—Ed.]

A Butting Collision on the Big Four R. R.

Sir: Under separate cover I am mailing you photograph of the most disastrous butting collision that ever occurred on the Peoria Division of the Big Four R. R., running from Springfield, Ohio, to Indianapolis, Ind. This wreck took place Oct. 27, 1906, at 10.30 o'clock, about two miles west of Springfield, Ohio, at a sharp curve in the road. Four men were killed and a number of cars were entirely demolished. Both engines were of the large "battleship" type and were badly wrecked.

FREIGHT WRECK ON THE "BIG FOUR" R. R. NEAR SPRINGFIELD, O., OCT. 27, 1906.

One peculiar thing about this accident was that neither engine left the track, as shown in the photograph.

When these two freight trains crashed together, one was carrying 1,500 tons, and running at 40 miles per hour, and the other was carrying 1,200 tons, running at 25 miles per hour. The cause was due to a mistake or negligence on the part of an operator who gave wrong instructions to the east-bound train, and after realizing his mistake fled to parts unknown.

Yours truly, S. S. Hause.

134 North Jackson St., Springfield, Ohio, Nov. 10, 1906.

The Templet System vs. Laying-Out in Bridge and Structural Shops.

Sir: I read in Engineering News of August 16, 1906, an article written by Mr. Jos. H. Springer, Sr., entitled "Against the Templet System of Fabricating Steel Work." Mr. Springer starts off by criticising articles written by Mr. John C. Moses, published in Engineering News of March 22 and 29 and April 5, 1906. I read Mr. Moses' articles and think if they were compiled in handbook form for the benefit of beginners in drafting rooms, they would certainly produce good results. There is only one statement of Mr. Moses' that I feel safe in criticising; that is in his description of templet making, wherein he says: "In making templets for plate-girders a board is first laid off to represent one leg of a flange angle and all odd holes of either leg of any flange are included. Four similar boards are clamped under this one and then all five are bored at once." My experience is that, in boring so many at once, owing to knots, hard and soft spots in lumber, the bit is very liable to run crooked. Try it and compare the bottom side of the lower piece with the top side of upper piece and note difference. The better way is, bore one piece and use it as templet to mark the others, putting the laid-out side in contact with the new piece to be bored.

Referring to the drawing of plan submitted by Mr. Springer: It certainly is a very nice plan to work from, but the question is, can it be scratch-marked cheaper than you can make templets and mark? I say no, and will prove it to the satisfaction of any fair-minded man. Mr. Springer requested us to follow him and he would show us how to lay off this work without a single wooden templet, and did it so quick it was startling, and to use his own expression, "killed the wooden templet theory."

While I am a firm believer in wood templets, I believe also there is such a thing as making too many templets. In my estimation no group or procession of holes should be laid out more than once. Holes duplicated in more than one templet should be laid out in the one most convenient to handle and used to mark holes in others.

Mr. Springer says a marker with one assistant will scratch-mark his girder span in two weeks, and that it will take a templet-maker and one assistant three weeks to make wooden templets. Is it reasonable to suppose that a marker with a steel tape and a slate pencil will space any faster than a templet-maker with a steel tape and a knife, all working conditions favoring the templet-maker, whose work is on a bench of suitable height, while the marker in all probability will have his on skids or trestles, which, when spacing, he must either walk around or climb over, and space a distance I would judge fifteen times greater than the templet-maker?

I will not question the ability of a marker with an assistant to scratch-mark this span in two weeks, but I would seriously question the quality of the work were they to do it in four weeks. I have seen considerable scratch-marking done on bridge work years ago. I never heard of any of the bridges falling down, which is evidence that drifting is not as injurious as some experts would have us believe. Nevertheless drifting is certainly injurious and costly.

Again, I do not know of a works that is not handicapped for space at times. Taking Mr. Springer's estimate for the time required to lay off this span as a basis, imagine the space that would be required for a marking department and the number of markers required in a works of large capacity where they scratch-mark their work.

I will explain what in my estimation is the most economical method to build the span instanced by Mr. Springer, in a works not equipped with multiple-punch or spacing table. I would certainly make wooden templets, beginning with the girder, which is symmetrical about the center. A half-length templet about 5¼ ins. wide is all that is necessary to put in all holes for top and bottom edges of webs, flange-angles and coverplates. For convenience in handling and putting on floor to form square in which to make templets for laterals and connections of stringers, I would make in two pieces of about equal lengths a templet full size for web splice, and two stiffener templets, one for common stiffener and one for floor-beam connection. A single strip full length of member is all that is required to mark webs and flange-angles of floor-beams and stringers. The templet for end connection angle is to be used to mark connection holes in webs. I will dispose of the few brackets and lateral bracing not shown as quickly as Mr. Springer did, but will make templets for base and cap plates.

In marking I would commence with girder webs, marking them 1, 2 and 3 from end. I would first shear a No. 2 plate to proper length and place Nos. 1, 2 and 3 in procession on blocking or skids fairly level and cambered to suit. I consider it advisable to put one gage line at bottom edge of each plate. Clamp templet on bottom edge, following gage line with care and clamp the plates together at splice at top edge to prevent any displacement. String a chalk line from end, close to templet, to center to represent a base line. Use a large square about 10 ft. on a side to locate center line of splice, squaring from base line. The distance the line is held away from templet at center is the amount of camber you will have in girder. Mark holes, then clamp strip on top edge, using stiffener templets to locate it, working from holes marked in bottom edge. One floor beam and one stringer web are to be marked in the same general way, and are then to be used as templets to lay out balance required. Mark one 50 ft. 10 in. and one 24 ft. 3½ in. flange plate and use as templets to mark balance of flange plates.

There is considerable less than 100 ft. of lumber used to make the templets, and the distance spaced by templet-maker is less than 200 ft., all straight work. Some templet-makers would require five days, while others would do it in half that time. I will allow ten hours as ample for an assistant to prepare lumber and bore holes. The average marker with an assistant will mark complete in less than six days. I base my estimates on a works equipped with power saws and boring machines and air or electric hoist facilities for handling metal and no delay to marker getting material.

Mr. Springer closes his article with the remark that a bridge such as he has shown should be assemb'ed in the shop before shipment. That in itself means a great deal in the way of cost and is not at all necessary, but I do consider it absolutely necessary that the floor-beam, stringer and lateral connections be carefully inspected before shipment.

Very truly yours,

J. H. Madigan.

10312 Prospect Ave., Chicago, Ill., Nov. 6, 1906.

[As the second sentence of the above letter refers to separate publication of Mr. Moses' articles, "Shop Hints for Structural Draftsmen," we may call attention to the fact that these articles have been reprinted as No. 6 of the little series of Engineering News Reprints (Paper, 4½ × 7 ins., pp. 40, 2 folding plates, 7 illustrations in the text, 25 cts.).—Ed.]

More Evidence as to Possible Corrosion of Steel Imbedded in Cinder Concrete.

Sir: In your issue of Nov. 1, 1906, I noted the article on corrosion of imbedded metal in cinder concrete floors, and the report of the Committee of the Structural Association of San Francisco on this subject, together with appendices. This is a subject that has been threshed over a great many times, and discussion is reopened from time to time when inexperienced persons note oxidation in metal that has been imbedded in concrete.

In dealing with corrosion of iron and steel, three active agents producing it are recognized. These are water, carbonic acid and sulphuric acid. Pure water, free from carbonic acid, will not attack steel, but unprotected steel work is rapidly corroded by either carbonic or sulphuric

acid in aqueous solution or by contact with these acids in a damp atmosphere.

More than ten years ago a number of analyses and tests were made at the suggestion of the writer by Booth, Garrett & Blair, chemists, of Philadelphia, and others, to determine the effect of cinder concrete on structural steel and imbedded metal. From a number of tests made under practical working conditions it was found that there is an initial oxidation when naked steel is imbedded in the wet concrete wherever voids occur in the concrete adjacent to the steel, and that this oxidation continues at a rapid rate as long as moisture is present; that after the moisture is eliminated and the average conditions obtain that are found in an ordinary building covered with a good roof, the oxidation progresses very slowly indeed, and at a decreasing rate with time. The above facts are true whether stone or cinder aggregates are used in the concrete.

In the absence of any evidence to the contrary, it is the writer's belief that the oxidation noted in the various buildings referred to in San Francisco was produced almost entirely during the period of the construction of the buildings, especially since in San Francisco they have a wet season during a large portion of the year, and the conditions could easily be such as to produce the results described during the period of construction.

Contrary to popular opinion in regard to cinder concrete, it actually contains very little sulphuric acid. The average of thirteen samples shows only about two-tenths of one per cent. of free sulphuric acid, and about the same amount of sulphur in the form of sulphides.

Sand usually contains only a trace of sulphur as sulphide, and this ingredient of the concrete can be ignored. Taking the average Portland cement as containing three per cent. of sulphuric acid, and only a trace of sulphur as sulphide, we have a total of sulphuric acid in the usual proportions of concrete in proportion to the cement, as follows:

	per cent.
100 parts cement, sulphuric acid	3.00
200 parts sand, sulphuric acid (none)	0.00
500 parts cinder (0.20 SO_3)	1.00
(0.20 S hydrated SO_3)	2.50
	6.50

Or the total sulphuric acid present in the concrete would be approximately 6.50% of the weight of the cement. If this amount of sulphuric acid were actually able to react upon the cement it would seriously affect it and retard its setting. This could only occur, however, if the cinder were ground to an extremely fine powder and intimately mixed with the cement before hydration. The sulphuric acid is, however, actually disseminated through a mass of cinder in lumps, many of which are hard and semi-vitrified, and the conditions are quite unfavorable to chemical reaction. Consequently, a small fractional part only of the acid is effective, and this part is completely neutralized by the alkaline properties of the cement, as is proven by the practical tests referred to above, and the fact that the cement sets in approximately the same period as when limestone, granite or trap rock aggregates are used for the concrete.

What precedes refers only to naked or unprotected metal imbedded in the concrete. It is well known that structural steel, as furnished in practice, is usually covered with two coats of a suitable weather-proof paint. This has in all cases been found sufficient to protect the structural members from any initial oxidation, due to voids in contact with the metal until the moisture of the green concrete has been completely eliminated.

In the experience of the writer, extending over fifteen years, I have personally examined a great many buildings where alterations, etc., have required both cinder and stone concrete to be removed where it has been in contact with structural steel. I should say that not less than 25 separate and individual cases of this kind have come under my personal observation, and in which the concrete had been in contact with structural steel for periods ranging from two to eight years. In all these instances, there was not a single one that did not show the paint on the steel work intact and in perfect condition with absolutely no sign of oxidation, except in a few small spots where the paint had been accidentally abraded in contact with hard or cutting edges during the construction of the building. Such spots where in contact with voids showed oxidation. The average surface, however, where cinder or stone concrete was in contact with structural steel (as where floor arches abutted against the steel beams), showed less corrosion than where the brick and stone mason work and ordinary mortar came in contact with other portions of the steel frame covered with the same paint. This was true in every case where the corrosive effects of the concrete and mason work could be compared. This result was probably due to the fact that brick work and stone masonry, on account of the method of placing it, generally had more voids in the surfaces in contact with structural steel than the concrete work.

From my experience and observation, I am thoroughly convinced that there is practically no difference, so far as the oxidation of steel is concerned, whether it is imbedded in cinder concrete or in stone concrete. In all cases a thorough mixture of the concrete should be required, in order that the cement may completely neutralize any acid that may be present in the aggregates.

The Structural Association of San Francisco is certainly making a mistake in condemning cinder concrete as a material for fireproofing purposes, on the strength of the few facts and evidence that have been presented in the report of their committee. They have ignored the fact that in many cases segmental arches are employed for floor construction, in which the strength is not dependent on any metal imbedded in the concrete, and in which the entire section of the concrete is in compression. The methods in which bars are used at intervals of from 12 to 24 ins. have also been excluded from their consideration. Where bars of considerable section are employed, the larger sections of the metal are much better adapted to resist oxidation, whether initial or otherwise, than where the metal is distributed uniformly in light section and in the form of mesh.

Cinder concrete, as stated in your very excellent editorial in the same issue, is one of the best fire and water resisting materials known at the present time, that is available at a low cost. It is light, porous and amply strong for the requirements of ordinary floor construction in fireproof buildings, developing approximately one-half the crushing strength of stone concrete. It is doubtful if any material will be found in the near future that will prove as efficient, as economical and as well adapted for fireproof floors as cinder concrete. It would, besides, be a decided hardship, on account of involving additional cost to owners of many buildings, if this material could not be used for fireproofing purposes.

Very truly yours.

A. L. A. Himmelwright.

Fuller Building, New York, N. Y., Nov. 9, 1906.

[The "sulphuric acid" in Portland cement, to which our correspondent refers, is not in the form of free acid, as might be inferred, or even of sulphuric anhydride (SO_3), but is in combination with other substances, as stable sulphates or sulphides, and can have no corrosive effect whatever upon steel. Further, the total amount of sulphur (analyzed as SO_3) in commercial Portland cement averages probably below 1%.

In cinders, on the contrary, the sulphur exists, as a rule, in a form which in the presence of moisture quickly changes to sulphuric acid. It is also unequally distributed. A chance lump of pyrites in the coal may result in a lump of clinker high in sulphur in the ash, which may chance to lie next to steel if the cinders of the ashes are used for reinforced concrete.—Ed.]

Sir: In your editorial comments on the report of the Committee of the Structural Association of San Francisco on the corrosion of reinforcing metal in cinder concrete floors, in your issue of Nov. 1, the question is raised as to why steel is sometimes protected from corrosion when embedded in cinder-concrete and at other times is rapidly eaten away.

The fact that cinders alone are very destructive to steel and iron is too well known to require for demonstration the examples furnished by the committee. The protection evidently lies in the cement, and when the steel is completely coated with a film of cement it is difficult to see how corrosion can occur. As is mentioned in the report, Prof. Norton has stated his belief, based on laboratory experiments, that corrosion results from too dry a mixture, and this would seem to be verified by actual experience. It was formerly the custom to mix concrete quite dry, so that water would only be brought to the top by tamping, and it is significant that of the buildings where serious corrosion was noted, two were eight years old, and even in the case of those built in 1902 it is not improbable that a dry mix was used.

I have had under my observation for some time the construction of a large building in close proximity to salt water, the roof and one floor of which is of cinder-concrete. The concrete was mixed very wet and in the proportions of 1 : 2½ : 5. There have been many cases where openings have been cut in the floors for the passage of pipes and other purposes, and in every case the reinforcing bars were found covered with a film of cement which adhered so closely as to be very difficult of removal. The bars were slightly rusty when placed, but no evidences of loose rust under the cement were found in any case, nor any indication that the steel had rusted in the concrete. A large number of bars were uncovered in the course of the work, many of which had been in several months, and the above conditions were found in all cases except the following: On the edge of a skylight opening, where the concrete was placed before the skylight curb, the water in the concrete had an opportunity to drain away, leaving the concrete porous. In this case the bars were rusted and the concrete did not adhere to them. This would seem to bear out the theory that a wet mix will coat the steel and preserve it from injury. The concrete throughout with the exception noted was very difficult to cut and appeared quite dense. The floors stood some very severe tests without sign of injury.

These facts, doubtless, can be duplicated by any practical concrete worker who employs modern methods and are presented merely as a partial verification of a theory already advanced. Undoubtedly the selection of the cinders and the mix of the concrete must be closely supervised, but this is true of many building materials that are in standard use, and should not condemn cinder-concrete for purposes to which it is suitable.

Very truly yours,

Charles C. Hurlbut.

320 Fifth Ave., New York City, Nov. 16, 1906.

AN AUTOMATIC ORE UNLOADER.

The Hulett automatic ore unloader shown in the accompanying figures, is an electrically operated machine. As seen from Fig. 1, a large grab bucket, with a capacity of 10 tons of iron ore, is attached to a vertical dependent leg, which in turn is suspended from a walking beam. The walking beam raises and lowers the leg and bucket as desired. The bucket leg is mounted on trunnions at the top, so that the bucket may be rotated around a vertical axis when operating in the hold of a boat. The bucket when open has a spread of over 18 ft., and can be further extended, if necessary, by means of a telescopic motion.

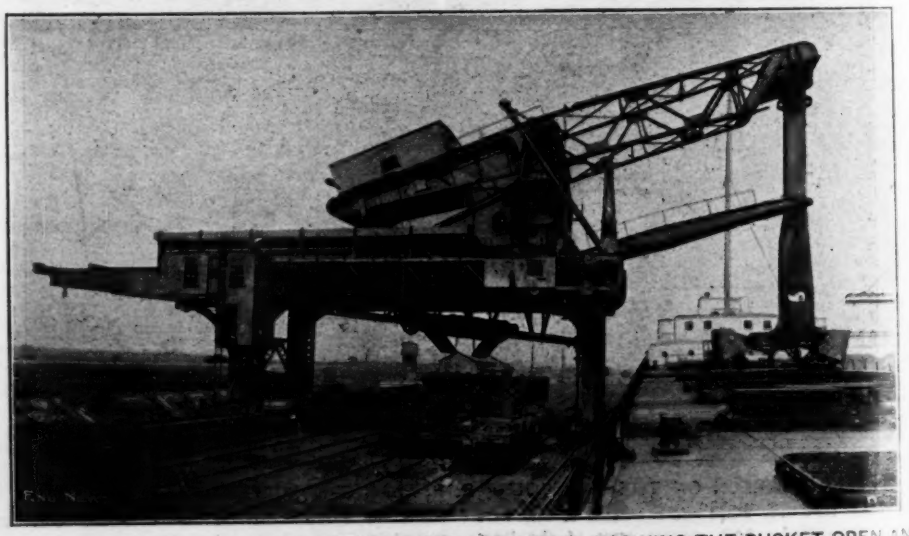


FIG. 1. A HULETT 10-TON AUTOMATIC ORE UNLOADER, SHOWING THE BUCKET OPEN AND THE CHUTES OF THE TRAVELING HOPPER IN DISCHARGE POSITION.
The Wellman-Seaver-Morgan Co., Cleveland, O., Makers.

The walking beam is mounted upon a carriage, which runs on a movable bridge. The carriage moves the bucket from over the hold of the boat back over the bridge until it is in a position to

discharge into the traveling hopper underneath the bridge, or vice versa, as shown in Fig. 2. The traveling hopper is provided with folding chutes for discharging the ore, and is so arranged that it is automatically dumped at any desired point. It travels the full length of the bridge, dumping the ore either into cars or into the storage pit seen back of the dock. Fig. 3 shows the position of the walking beam and counterbalance when the

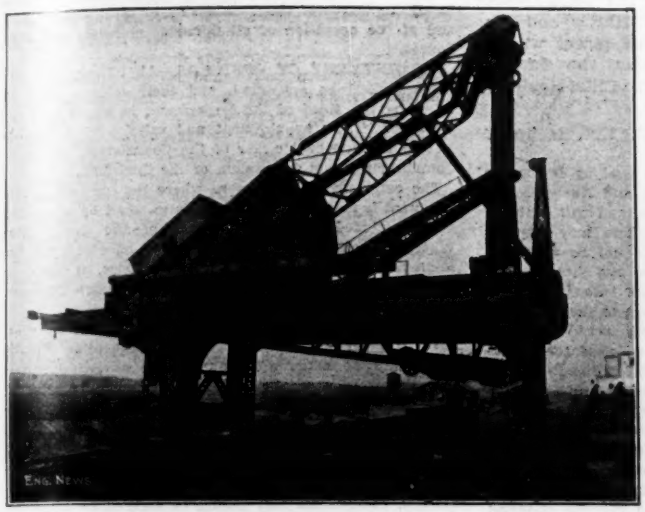


Fig. 2. View Showing Position of Unloader Leg, When the Bucket is in the Discharge Position.

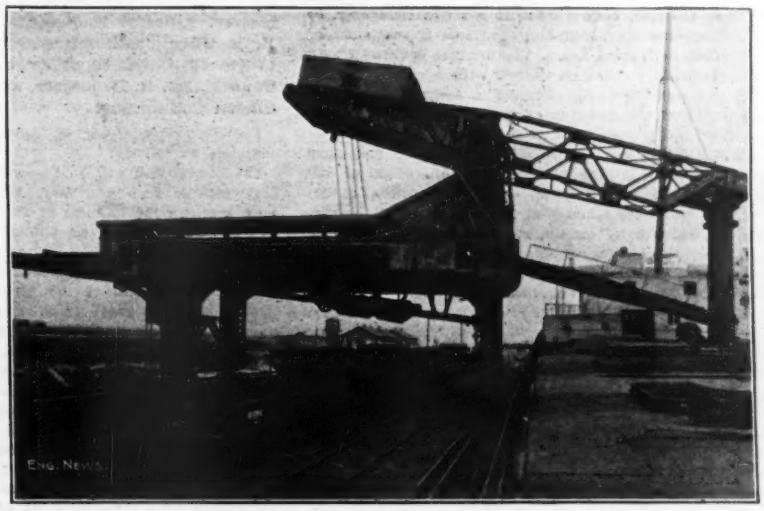


Fig. 3. View Showing Position of Walking Beam, When the Bucket is at Work in the Hold of a Boat.

FIGS. 2 AND 3. A HULETT 10-TON AUTOMATIC ORE UNLOADER IN EXTREME POSITIONS.

bucket is lowered into the hold of a boat. As seen from the illustrations the bridge spans from railway tracks and is mounted upon trucks, which run on a double track laid on the dock.

The unloader is operated by electric motors, the current being obtained through sliding contacts. An aggregate of 360 HP. is required to operate the machine, an 85-HP. motor being used to open and close the bucket, a 150-HP. motor for hoisting the walking beam, a 50-HP. motor for moving the walking beam carriage backward and forward and a 75-HP. motor for operating the traveling hopper and moving the bridge.

We are indebted for the above information and illustrations to The Wellman-Seaver-Morgan Co., of Cleveland, O., who built the machine and installed it at the docks of the Pennsylvania Railroad at Buffalo, N. Y.

THE MECHANICAL EXAMINATION AND ANALYSIS OF MANUFACTURED RUBBER.

Two papers, one on "The Mechanical Examination of Manufactured India Rubber," Pierre Breuil, and the other on a "Study of the Methods of Testing Caoutchouc," Em. Camerman, presented before the Brussels Congress of the International Association for Testing Materials and printed in the French journal "Le Caoutchouc et la Gutta-percha," contain some interesting information regarding the mechanical properties of manufactured rubber and its analysis. The results obtained by different experimenters regarding the mechanical properties of rubber may be summarized as follows:

Joule, Villari and Schmulewitsch found that rubber, unlike metals, becomes warm when it is stretched and cools when allowed to contract. This phenomonon only occurs, however, after a thermal change in the opposite direction. M. Chauveau ascribes this property of rubber to the porosity of the material.

M. Stévart concluded from his experiments that Hooke's law governing the extensibility of metals does not apply to caoutchouc, for the curves are not straight lines; the curves of extensibility exhibit a sudden change in form, being S-shaped; elongation is in proportion to the length of the sample, while it increases as the rapidity of applying the test is decreased; calculated on the original sections, the breaking loads vary from 0.5 to 0.8 kg. per sq. m. m. The work absorbed in stretching the rings he examined was eleven times that required to stretch steel. These results apply, of course, only to rubber of the same nature as that used in his tests.

M. Breuil's experiments, on rings 10, 20, 30, 40 and 60 m. m. wide, cut from the same tube of para rubber, show that Stévart's statement, that the curves of extensibility were S-shaped, was correct; that the loads (calculated on the original areas) necessary to produce a given elongation are practically the same, but that as the rings become wider the ultimate breaking weight diminishes, and that, therefore, rubber is a homogeneous material.

M. Heinzerling and M. Pahl, in order to determine the influence of added substances to pure rubber, determined the modulus of elasticity, the modulus of rigidity and the elongation at the breaking point of some 50 different specimens. Their conclusions may be summed up as follows:

Every addition of organic or mineral matter decreases the elongation at the breaking point of rubber, the best results in this respect being obtained with 10% of sulphur; organic substances such as rosin oil, colophomy and asphaltum, and mineral substances such as vermilion and slaked lime increase the elongation at the breaking point; the breaking weight at the elastic limit (?) is increased by the addition of chalk, fluorspar, zinc oxide and particularly magnesia; zinc oxide, lead oxide, chalk, magnesia, slaked lime, asphaltum and glycerine increase the breaking weight.

M. Breuil carried on similar experiments with four samples of rubber, viz., A quality, 95% para rubber, 5% sulphur; B quality, 90% para rubber, 10% antimony sulphide; C quality, 43.7% para rubber, 19.04% substitutes and regenerated rubber, 34.6% mineral matter, and the remainder sulphur; D quality, 17 kilos. rubber, 3 kilos. regenerated rubber, 20 kilos. mineral matter, 1 kilo. sulphur. This material was made up into rings 60 m. m. in internal diameter, 2 m. m. thick in the walls and 20 m. m. broad. The elongation curves obtained from these samples showed that, while the form of the curves changed, the change did not always correspond with a degree of elongation equal to twice the original length, as supposed by M. Stévart, but varied according to the material tested. Tests carried out to discover whether foreign substances introduced into the rubber acted as inert bodies or otherwise, indicated that foreign substances which harden the plastic material, hinder its movement and increase the loads it will bear. Samples from the A and B qualities broke almost without load, as if they consisted of a plastic substance like wax, while samples of C and D qualities exibited a resistance, which increased as the elongation increased and in the same ratio as the amount of mineral matter present.

Tests made to determine the influence on rubber of rapidity of elongation indicated, apparently, that for a given load, elongation increases with the duration of the test.

Experiments with the above samples to determine the effect of repeated elongation showed that the load curves do not agree with the extension curves, the divergence being the greater for the sample containing the less caoutchouc. Also that the two curves tended to become alike as the number of extensions increased.

The results of tests of leather and rubber canvas belts, made by M. Ogier in 1871, are summarized by M. Bobet as follows:

> The resistance to traction, of rubber-canvas belts, per square millimeter of section is at least equal to that of leather belts and is independent of the dimensions of the belt. In practice, therefore, rubber-canvas belts will bear as great a strain as leather belts. The rubber outside the fabric does not confer any strength upon the belt. Under a given load the elongation of rubber-canvas belts is half that of leather belts; while after a load of 0.02 kg. per square millimeter the latter exhibit a permanent elongation, whereas the former return to their original dimensions.

The effect of compression upon rubber has been investigated by several experimenters. M. Boileau found that the compression was not proportional to the load and that there was a maximum compressibility. M. Hovine concluded that rubber should not be compressed more than to two-fifths of its original size, while M. Werder found a definite elastic limit and a modulus of elasticity which varied from 0.5 to 0.55 kg.

M. Breuil's tests showed that rubber exhibits a phenomenon of hysteresis in compression; that it becomes heated when repeatedly compressed; that permanent deformation occurs, particularly with the softer varieties.

Methods for estimating the quantities of impurities in manufactured rubber are very important, since resins, substitutes, i. e., factitious rubber, free sulphur and old rubber are very harmful to the life of the material, according to M. Camerman. An important consideration in the manufacture of rubber goods is the vulcanization, for if the temperature is too high during this process, substances of a resinous nature may be produced, thus destroying the value of the article.

For these reasons he states that a consumer should insist upon having a rubber (1) composed essentially of pure para caoutchouc, or rubber that contains less than a prescribed proportion of resin; (2) containing little free sulphur; (3) free from substitutes; (4) containing no regenerated rubber.

He then describes the following analytical process which, in his opinion, gives sufficiently accurate results, for most investigations, for de-

termining the composition of manufactured rubber:

DETERMINATION OF RESINS.—A convenient quantity of the rubber is reduced to the finest possible powder by rubbing the sample with a rough file. If the rubber is pure or not loaded (i. e., if it floats), 1 gram is prepared; if its flexibility shows that only a moderate amount of loading matter is present, 2 grams are taken; but if it is so hard that it appears to be highly charged with mineral matter, 3 grams of filings are made ready. The appropriate quantity of material is then brought into a 120 or 150 c. c. flask fitted with a reflux condenser, 50 c. c. of acetone are added, and the whole is gently boiled on a water bath for 4 hours. The mixture is thrown on a filter, and the residue is washed with acetone; the filtrate and washing being collected in a thin tared basin. The liquid in the basin is evaporated at a gentle heat, and the solid matter is weighed.

DETERMINATION OF SUBSTITUTE.—The substance remaining on the filter is introduced into a 120 or 150 c. c. flask connected with an inverted condenser as before, and boiled for 4 hours on a water bath with 50 c. c. of a 5% solution of caustic soda in 95% alcohol. The mixture is then thrown on a filter and the insoluble matter is washed with alcohol. To estimate the substitutes in the filtrate, 8 or 10 c. c. of water are added, and the whole of the alcohol is driven off, but the residue is not dried. It is next diluted with about 200% of water, and dilute hydrochloric acid is introduced to render the liquid faintly acid. The fatty acids of the substitutes are thus precipitated, and, after standing for 12 hours, collect on the surface as flocks which can easily be filtered off. After washing with hot water, the filter and its contents are laid on bibulous paper to absorb most of the water, and they are then transferred to a small Erlenmeyer flask containing about 20 c. c. of ether. When all is dissolved, the etheral liquid is filtered, the filtrate being received in a tared vessel. After driving off the ether at a gentle heat, a dry residue is obtained which represents the fatty acids of the substitutes; and, according to the author's experiments, its weight may be considered practically identical with the amount of substitute in the sample.

DETERMINATION OF FREE SULPHUR.*—Two grams of rubber raspings are digested for six hours in 250% of boiling alcohol, and the residue is washed with alcohol. The filtrate is mixed with 20% of strong caustic soda solution, brought to the boil, and evaporated on a water bath. The residue is taken up in nitric acid diluted with half its volume of water, again boiled, and evaporated to dryness. The solid matter is dissolved in hydrochloric acid, and the sulphate in the liquid is precipitated with barium chloride in the usual manner.

ESTIMATION OF SULPHUR COMBINED WITH SUBSTITUTES.—The material which has been freed from uncombined sulphur by means of substitute present. The insoluble portion is washed with boiling water, and the liquid is evaporated to dryness. It is taken up in dilute nitric acid, and further treated as in the preceding paragraph.

ESTIMATION OF TOTAL SULPHUR.—One gram of the finely divided caoutchouc is triturated with a mixture of equal parts of pure manganese dioxide and sodium carbonate. A tall porcelain crucible is charged with one gram of the oxidizing mixture, the diluted rubber powder is next put in, and then another layer of the oxidizing mixture. The crucible is inserted into a muffle furnace, and kept at a red heat for 1½ hours. The mass is carefully treated with dilute hydrochloric acid, evaporated to dryness, dissolved again in boiling water containing a little hydrochloric acid, filtered if there is any residue, and the hot solution is precipitated with barium chloride as usual.

DETERMINATION OF INERT MATTER.—A determination of the inert matter is important principally because it enables the analyst to ascertain the proportion of caoutchouc in the manufactured rubber, and so to calculate the proportion of resin in the caoutchouc. It is this proportion, indeed, that indicates most accurately the value of the material under examination.

If the rubber is loaded with fairly non-volatile matter, such as litharge, zinc oxide, or chalk, the amount of inert matter present may be estimated by ignition. The sample is introduced into a porcelain crucible supported in a circular hole made in a sheet of asbestos millboard, the flame of a Bunsen burner being caused to play on the lower part of the crucible in such fashion that the caoutchouc distills away without igniting. This is easy to manage as the asbestos protects the interior of the crucible from all contact with the flame itself. When the caoutchouc is entirely carbonized, the power of the burner is increased, care being taken that the temperature does not exceed a dull red heat.

If the rubber is loaded with inert matter that decomposes easily, such as the sulphide of mercury or antimony, special processes for determining the proportion must be adopted, the selection of which is to form the subject of future investigation.

*M. Pontis; Revue generale de Chimie pure et appliquee, Jan. 10, 1904.

IMPORTANT CHANGES IN THE PANAMA CANAL ORGANIZATION.

On Nov. 17 an Executive Order was issued by the President making some important alterations in the organization under which the work of constructing the Panama Canal is to be carried on. The order is printed in full below. It is rumored in Washington that this order is likely to be followed, upon the President's return to Washington, by changes in the personnel of the Commission. Messrs. Admiral Endicott, Gen. Harris and Mr. B. M Harrod will retire and their places will be taken by Chief Engineer Stevens, the General Counsel, Mr. R. R. Rogers, and the Chief Sanitary Officer, Col. Gorgas.

The Executive Order of April 1st, 1905, is hereby changed, as follows:

The Commission will hold quarterly sessions during the first week of February, May, August and November, of each year, on the Isthmus of Panama, and will continue each session as long as public business may require. Further notice of such meetings shall not be necessary to their regularity. The Commission may hold special sessions at the call of the Chairman. Four members shall constitute a quorum and the action of such majority shall be the action of the Commission.

The Commission, under the supervision of the Secretary of War and subject to the approval of the President, is charged with the general duty of the adoption of plans for the construction and maintenance of the Canal, and with the execution of the work of the same; for the purchase and delivery of supplies, machinery and necessary plant; the employment of the necessary officers, employees and laborers, and with the fixing of their salaries and wages; with the operations of the Panama Railroad Company and Steamship Lines as common carriers; with the utilization of the Panama Railroad as means of constructing the Canal; with the Government and Sanitation of the Canal Zone and with all matters of sanitation in the cities of Panama and Colon and the harbors thereof; with the making of all contracts for the construction of the Canal or any of its needful accessories; and with all other matters incident and necessary to the building of a water-way across the Isthmus of Panama, as provided by the Act of Congress, June 28, 1902.

The Executive Committee, as provided for in my Executive Order of April 1st, 1905, is hereby abolished.

In order to promote the greatest harmony between the heads of Departments, and to secure results by the most direct methods, the following organization shall be created:

The organization shall consist of the Chairman and the following heads of Departments: Chief Engineer, General Counsel, Chief Sanitary Officer, General Purchasing Officer, General Auditor Disbursing Officer, and Manager of Labor and Quarters. The duties of each shall be as follows:

1. The Chairman shall have charge of all Departments incident and necessary to the construction of the Canal or any of its accessories.
2. He shall appoint the Heads of the various Departments, subject to the approval of the Commission.
3. The Head of each Department shall report to and receive his instructions from the Chairman.
4. He shall have charge of the operations of the Panama Railroad and Steamship Lines.
5. He shall perform such other duties as may be assigned to him from time to time by the Secretary of War.

A minute of every transaction of the Chairman shall be made and one copy of the minutes shall be forwarded to the Secretary of War and another copy transmitted for the consideration of the Commission at its next meeting.

The Chief Engineer shall have charge of:

1. All engineering work relating to the Canal and its accessories.
2. All construction work on the Isthmus of Panama.
3. The operation of the Panama Railroad so far as same relates to Canal construction work.
4. The custody of all the supplies and plant of the Commission upon the Isthmus.
5. In the absence of the Chairman from the Isthmus, the Chief Engineer shall act for him in all matters requiring prompt attention, such action to be reported to the Chairman for his action, but the action of the Chief Engineer shall be in full force and effect until disapproved by the Chairman.

The General Counsel shall have charge of:

1. All legal matters pertaining to the Commission, whether in the United States or on the Isthmus of Panama.
2. The administration of civil government within the Canal Zone, and shall exercise, through a local administrator, the authority heretofore vested in the Governor of the Canal Zone.

The Chief Sanitary Officer shall have charge of:

1. All matters of sanitation within the Canal Zone, and also in the cities of Panama and Colon, and the harbors, etc., so far as authorized by the treaty, Executive Orders, and decrees of December 23, 1904, between the United States and Panama, relating thereto.
2. The custody of all medical supplies needed for sanitary purposes.

The General Purchasing Officer shall have charge of the purchase and delivery of all supplies, machinery and necessary plant.

The General Auditor shall have charge of the general bookkeeping, of property accounts, of statistics, of administrative audit of the Commission, and of the accounting, bookkeeping, and audit of the Government of the Canal Zone.

The Disbursing Officer shall have charge of time keeping, of preparation of pay-rolls and vouchers, and of payment of same.

The Manager of Labor and Quarters shall have charge of the employment of all necessary labor secured from the West India Islands or Central and South American countries; of the general personal records of all employees; of all quarters, and shall assign same to all employees of the Commission or of its contractors; and of the operation of all Commission hotels and mess houses.

APPOINTMENT OF OFFICERS.—All officers and employees shall be appointed, and their salaries shall be fixed, by the Head of the Department in which they are engaged. Their appointment and salaries shall be subject to the approval either of the Commission, or, if the Commission is not in session, of the Chairman.

The employment of laborers where the contract of employment is made in the United States, shall be negotiated and concluded by the Chairman of the Commission. Where the employment of laborers is effected upon the Isthmus, or outside of the United States, it shall be conducted under the supervision of the Chief Engineer, subject to the approval of the Chairman.

CONTRACTS.—Contracts for the purchase of supplies, involving an estimated expenditure exceeding $10,000 shall only be made after due public advertisement in newspapers of general circulation, and shall be awarded to the lowest responsible bidder, except in case of emergency, when, with the approval of the Secretary of War, advertising may be dispensed with. In the making of contracts for supplies or construction involving an estimated expenditure of more than $1,000, and less than $10,000, competitive bids should be secured by invitation or advertisement whenever practicable.

REPORTS.—The Head of each Department shall make a report upon the work and operation of his Department to the Isthmian Canal Commission from time to time and as often as may be required by the Chairman of the Commission.

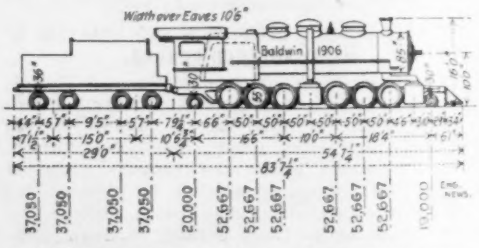
The Chairman of the Commission will make a report to the Secretary of War, setting forth the results accomplished by each Department of the work, at least annually and as often as he may deem advisable or the Secretary may require.

The Secretary of War will make to the President a report at least annually, and as often as he may deem advisable or the President may require.

All Executive Orders relating to the subject of the Panama Canal, excepting so far as they may be inconsistent with the present order, remain in force.

WHEEL LOADINGS OF THE MALLET DUPLEX LOCOMOTIVE ON THE GREAT NORTHERN RY.

In the drawing showing wheel loadings of the new Mallet Duplex Compound Locomotive on the Great Northern Ry., published in our issue of



Oct. 18, several errors were made to which a correspondent has called our attention. We therefore reprint the drawing here with the errors corrected.

NOTES FROM ENGINEERING SCHOOLS.

COLUMBIA UNIVERSITY.—The Board of Extension Teaching has announced a series of nine evening technical courses to be given in the buildings of the Teachers' College at West 120th St. and Broadway. The courses to be given cover the following subjects: Drafting, machine design, structural design, strength of materials, steam engineering, electrical engineering, engineering physics, elementary mathematics and special engineering problems. Complete information regarding these courses can be obtained by addressing Evening Technical Courses, Extension Teaching, Columbia University, New York City.

THOMAS S. CLARKSON MEMORIAL SCHOOL OF TECHNOLOGY.—The decennial anniversary of the institution will be celebrated Nov. 27-30. The program includes an opening address Tuesday evening, Nov. 27, at 8 p. m.

On Thursday will occur the decennial alumni reunion and dinner, followed in the evening by a musical recital and ball in Clarkson Hall. The decennial memorial exercises will be held in the chapel Friday morning at 11 o'clock. From 5 to 7 p. m. a public reception will be given in the library, followed, at 8 p. m., with the decennial founder's day exercises in the chapel. Among the speakers will be Rt. Rev. Richard Henry Nelson, D. D.; Rt. Rev. William Croswell Doane, D. D., LL. D., and Prof. Henry Smith Pritchett, Ph. D., LL. D.

A CYCLONIC STORM swept over Mississippi, Arkansas and Tennessee Nov. 17 and 18, destroying much property and killing several people. The wind storm was accompanied with rain, which caused many washouts on the railroads. At Winona, Miss., brick churches and residences, the opera house and post-office were destroyed, while many other buildings were badly damaged. Mathison and Columbus, Miss.; West Point, Ala., and Moscow and Jackson, Tenn., also suffered heavily. The storm destroyed the telephone and telegraph lines and flooded many towns and much railway track.

FLOODS IN WASHINGTON AND OREGON, Nov 14 to 16, inundated some 200 sq. miles of territory, according to press dispatches. The valleys of the White, Duwamish, Ceder, Green, Stuck, Black, Puyallup, Cowlitz, Williamette and Snoqualamie Rivers were flooded, destroying much property and drowning several people. The flooded country includes practically all the low land of the Puget Sound from Portland, Ore., to Tacoma, and Seattle, Wash. The Cowlitz River rose 20 ft. above the low-water mark at Kelso, Ore., while many towns situated on the banks of rivers were submerged by the rising waters.

SPREADING RAILS are said to have caused the wreck of a passenger train, on the Wildwood Branch of the West Jersey & Seashore R. R., near Wildwood, N. J., Nov. 14. The coaches were rolled down an embankment, but none of the passengers were killed or seriously injured.

A COLLISION OF STEAMBOATS, Sunday night, Nov. 18, in Puget Sound, near Alki Point, Wash., caused the death of 42 passengers. A small river steamboat, the "Dix," undertook to cross the bow of the Alaska steamboat "Jeanie" and was run down. The "Dix" sank almost immediately, and it is thought that only the passengers who were on the open deck escaped. She carried 79 passengers, 37 of whom were rescued. The "Jeanie" carried no passengers and was not injured by the collision. The accident is said to have been due to the pilot of the "Dix," who turned his boat suddenly into the path of the larger steamboat.

THE CARRYING CAPACITY OF THE BROOKLYN Bridge cars during the rush hours was increased Monday, Nov. 5, by the substitution of twenty new cars for the same number of old ones. As the carrying capacity of each of the new cars is 150, while that of each of the cars replaced was 125, there is a gain of 25 per car. The twenty new cars therefore increase the carrying capacity by 500 every 18 minutes, or 1,667 per hour, 18 minutes being the time required by a train to make one complete trip, including stops, over and back. The same total number of bridge trains and the same schedule are in use as before; that is, there are eighteen 5-car local trains running under a 55-second headway during the rush hours, which are from 4.40 to 6.20 in the evening and from 6 to 9 in the morning. During these hours no Brooklyn elevated trains cross the bridge, and the bridge cars are run across entirely by cable. With this last installment all of the bridge cars are now of the improved style introduced last summer, and their present carrying capacity is 45,000 per hour. As to the trolley cars, the present schedule allows for 326 cars per hour. On these, 75 persons can be carried per car, so that the capacity of the surface cars is about 24,500 per hour. This gives for the total capacity of all the cars crossing the bridge during the rush hours, about 69,500 per hour.

THE FIRST BATTLESHIP ever built in Japan was launched at Tokio, Nov. 15. According to unofficial reports the boat, the "Satsuma," is 482 ft. long, with a 83½-ft. beam, and has a displacement of 19,200 tons. Her armament will consist of four 12-in. guns, twelve 10-in. guns, and twelve 4.7-in. guns, while her speed will be 19 knots. She was built by Japanese labor exclusively, great secrecy being maintained regarding her design. It is interesting to compare the "Satsuma's" main dimensions with those of the new British battleship, the "Dreadnought," which are as follows: Length 530 ft., width 82 ft., displacement 18,000 tons, speed 21 knots, and main battery ten 12-in. guns. From these dimensions it is seen that the "Satsuma" compares quite favorably with England's largest ship.

MORE THAN 6,000 BUILDINGS have been erected in San Francisco's burned district, since the fire last April and Oct. 31, according to the "Bulletin of Progress" published by The California Promotion Committee, while more than $50,000,000 have been spent in improvements. Market and its debouching streets have been practically cleared of debris, and the sidewalks are being rapidly repaired. Debris is being removed at the rate of 200 carloads per day, while some 35,000 men are employed in construction work. Of the 4,486 building permits issued, with a total valuation of $27,020,033, 2,102 were for permanent buildings.

THE ABNORMAL AMOUNT OF TYPHOID FEVER at Watertown, N. Y., in September of this year, was mentioned in the course of an editorial note published in our issue of Nov. 15. Through the courtesy of Hazen & Whipple, Consulting Engineers, New York City, we are enabled to state that the typhoid in Watertown during the four months just passed has been as follows: July, 5 cases and no deaths; August, 13 cases, of which 2 were imported, and no deaths; September, 26 cases, of which 7 were imported, and no deaths; October, 26 cases, of which 7 were imported, and 1 death.

THE MALLET COMPOUND DUPLEX LOCOMOTIVES for the Erie Ry. will in point of weight exceed the similar engines of the 2-6-6-2 class for the Great Northern Ry., which were recently described in our columns. The three new engines will be of the 0-8-8-0 class, and are to be built by the American Locomotive Co. The four rear axles will be carried in the main frames and driven by the high-pressure cylinders; the four front axles will be carried in a truck frame pivoted at the rear of the truck and will be driven by the low-pressure cylinders. The Walschaert valve gear will be used, operating piston valves for the high-pressure and flat valves for the low-pressure cylinders. The firebox will have a combustion chamber 4 ft. long, and the cab will be just behind the smokebox. The general dimensions will be as follows:

Driving wheels	4 ft. 3 ins.
Wheel base, each group	14 ft. 3 ins.
Wheel base, total	39 ft. 2 ins.
Weight	410,000 lbs.
Cylinders	25 × 28 ins. and 39 × 28 ins.
Boiler, diameter	7 ft. 0 ins.
Steam pressure	215 lbs.
Tubes, No. 468; length	21 ft. 0 ins.
Firebox	10½ × 9½ ft.
Heating surface, tubes	5,760 sq. ft.
Heating surface, total	6,108 sq. ft.
Grate area	100 sq. ft.
Coal	16 tons.
Water	8,500 galls.
Tractive effort	98,000 lbs.

EXTENSIVE CONSTRUCTION of blast furnaces, open-hearth steel plants and Bessemer plants were lately noted in "The Iron Trade Review." According to this paper there are 21 blast furnaces, with an annual capacity of 2,310,000 tons, now under construction, while 7 with an annual capacity of 968,000 tons have recently been completed. New furnaces to the number of 27, with an annual capacity of 2,965,000 tons, have been authorized, which, with 4 old furnaces long idle, with an annual capacity of 365,000 tons, soon to be blown in, makes a grand total of 59 new blast furnaces with an annual capacity of 6,558,000 tons. These figures do not include several furnaces that are rebuilding, so that a safe estimate of the new furnace capacity would be 7,000,000 tons, annually. There are now 47 open-hearth furnaces, with an annual capacity of 1,016,000 tons, under construction, while 21 furnaces, with an annual capacity of 530,000 tons, were lately completed. The building of 30 new open-hearth furnaces has been authorized, which will make a total new open-hearth furnace capacity of 2,740,000 tons, for 98 furnaces. Two 10-ton Bessemer converters, with an annual capacity of 360,000 tons, have been installed during the year, which, added to the gross tonnage of the open-hearth furnaces, gives a grand total of 3,100,000 tons of new steel making capacity. The entire capacity of these new furnaces will probably not be operative before 1908 or 1909, but after that date all furnaces will doubtless be in service.

THE RIO GRANDE IRRIGATION PROJECT, NEW Mexico involving the ultimate construction of an immense dam across the Rio Grande, has been initiated by awarding a contract for a subsidiary portion of the whole project. The work to be done under this contract is the construction of the Leesburg diversion dam and a canal to connect with the old Las Cruces irrigation system, by means of which it is hoped that water can be supplied during the irrigation season in 1907 to 1,000 acres of land in the Mesilla Valley. The sum of $200,000 only has been appropriated for construction work thus far, inasmuch as the extensive demands upon the reclamation funds would not permit entering on the full enterprise at present. The Rio Grande project includes a dam across the river near Engle, N. Mex., 225 ft. high, 180 ft. thick at the bottom, 20 ft. thick at the top, and 1,150 ft. long measured on the crest. The reservoir thus formed will have a capacity of 2,000,000 acre-feet, and will store water for the irrigation of 180,000 acres, of which 110,000 lie in New Mexico. The estimated cost of the dam is $5,300,000, and of the entire irrigation system, $7,200,000. The project is under the direction of the U. S. Reclamation Service.

A FIREPROOF EXCURSION STEAMER has been built for the Potomac River service of the Norfolk & Washington Steamboat Co., the fireproof construction having been adopted as a result of the lessons of the burning of the New York excursion steamer "General Slocum." All the framework is of steel, with steel decks, partitions and sheathing, wood being used only for such fittings as doors, window frames, etc. Even the cabin berths and the seat frames are of steel. The vessel is driven by side wheels 18 ft. 3 ins. diameter, having nine feathering buckets 3 × 9 ft. The 14-in. shaft is driven by an inclined compound engine having cylinders 30 × 66 ins. and 64 × 66 ins., with connecting rods 12 ft. 4 ins. long. The steamer is 262 ft. long over all, 38 ft. beam, 63 ft. wide over the guards, and 14 ft. 6 ins. deep, with a maximum draft of 8 ft. 6 ins. The speed is about 18 miles an hour with the engines working 53 revolutions. There are four Scotch marine boilers. The steamer was built by the Newport News Shipbuilding & Dry Dock Co., of Newport News, Va.

AUTOMATIC BLOCK SIGNAL APPARATUS for a thousand miles of railway has been contracted for by the Boston & Maine R. R. Co., with the Union Switch & Signal Co. This is one of the largest if not the largest block signaling contract ever made.

A PAVING DECISION recently handed down by the Supreme Court of New Jersey, in the case of The Asphalt Co. vs. The City of Atlantic City, terminates litigation which has extended over some two years. The suit was brought to prevent the city and the Standard Bitulithic Co., as contractor, from improving Atlantic Ave. with bitulithic pavement. The application for a writ of certiorari was denied on the following grounds:

(1) A municipal council may determine, in the exercise of the discretion vested in it, to pave a public highway with a special or patented material, and to ask for bids upon such material alone, when the price at which any one may obtain the patented material is definitely fixed, and known to be obtainable by all at such price, before the bids are asked for.

(2) It is within the right and power of a municipality to award a contract for a public work, as an entirety, rather than to parcel it out, where it is evident that the entire work can be done with greater expedition and better results under a single contract.

SOME OF THE PRINCIPAL IRRIGATION PROJECTS of the U. S. Reclamation Service were in the following condition on or about Nov. 1: The Gunnison tunnel, forming a part of the Uncompahgre project in Colorado, had been excavated to a total length of 18,739 ft., of which 757 ft. was dug in October. The concrete lining was begun on Oct. 25, but several thousand feet of concrete floor is already in place. On the Strawberry Valley irrigation project in Utah about 120 ft. of tunnel had been completed by Nov. 1. A wagon road 31 miles in length has been completed to the east end of the tunnel. There will be a wagon road 24 miles long between the railroad and the other end of the tunnel. On the Pathfinder Dam, which forms an important part of the North Platte irrigation project, Wyoming-Nebraska, 2,500 cu. yds. of concrete were laid during October. During a week of continuous stormy weather 16 laborers left the camp. The scarcity of laborers in October was such that only half of the capacity of the plant for laying masonry was reached during the month.

INTERNATIONAL WATERWAYS were discussed by the Canadian section of the International Waterways Commission at a meeting in Ottawa on Nov. 8, preliminary to a joint meeting with the United States members on Nov. 13. The commission had before it the question of certain works, proposed by the Minnesota Canal & Power Co., who desire to turn from their natural courses the waters of Birch Lake, Birch River, and other streams that now flow into Rainy River, but which the diversion in contemplation would carry southward into Lake Superior near Duluth. This would lower the level of Rainy River from six to seven inches, which would render the navigation of that stream impossible in the season of lowest water.

Mr. Smith L. Dawley, of Ogdensburg, N. Y., is desirous of constructing at Long Sault Island a breakwater designed to produce a water power. It is feared that the execution of this plan might have an injurious effect upon the Cornwall Canal by increasing the strength of the current between Long Sault Island and the Canadian shore.

A new proposal was brought to the attention of the waterways commission at the meeting by Mr. Charles R.

F. Smith, a New York capitalist, which has for its object the improvement of navigation of the Richelieu River from its source in Lake Champlain, through to where it empties into the St. Lawrence. It is proposed to deepen the river from Lake Champlain to Lake St. John, a distance of about 22 miles, and from Lake St. John to Chambly basin, a distance of about 12 miles.

THE NEW YORK CENTRAL RAILROAD COMPANY was found guilty, Nov. 10, of granting $26,000 in rebates on sugar shipments to the American Sugar Refining Co. at Cleveland. This is the second time within a month that this railway company has been found guilty of violating the Elkins law in granting rebates. The first trial, which was on sugar shipments to Detroit, resulted in the company being fined $108,000 and its traffic manager $6,000.

A HEIGHT LIMIT FOR BUILDINGS at Springfield, Mass., is proposed. The ordinance to effect this provides that after its passage no building shall be erected to a height greater than 1½ times the width of the street upon which it is located, and that no building shall be erected to a height exceeding 100 ft. in the business section, and 80 ft. in the residence section of the city, the boundaries between the two sections to be designated from time to time by the board of aldermen. Where the front of a building is placed back of the street line the distance between the two lines may be considered as added to the width of the street, provided that this does not give rise to heights in excess of the limits just stated. Greater heights than 100 ft. and 80 ft., respectively, are permitted where the upper portions of the building, beginning at the height limit, are set back at a rate of of least 4 ft. horizontal to every 5 ft. vertical. The height limits named do not apply to belfries, chimneys, balustrades, weather vanes, etc., nor do they apply to gasholders, grain elevators, coal elevators, stand-pipes, water tanks and sugar refineries. A lengthy hearing on the ordinance was held on Nov. 8, and to a report of the discussion the Springfield "Daily Republican" devoted a page of its issue of Nov. 9, 1906. Nearly all the speakers supported the ordinance, and in addition a number of letters were read, to the same effect. One of the letters was from Prof. Wm. T. Sedgwick, of the Massachusetts Institute of Technology, Boston, Mass. This letter concluded as follows:

> Strong sanitary objections to the construction and occupancy of sky-scrapers are manifest, and in my opinion the physical as well as the material prosperity of the people as a whole imperatively requires a reasonable limitation of the height of buildings and of the consequent crowding of large numbers of people upon small areas.
>
> The specific objections to tall buildings raised by Professor Sedgwick were the fact that they deprive their inmates of the beneficial effect of sunlight, and, especially on muggy days, interfere with air circulation; also that they tend to dampness and create nervous strain, the latter due to "the close aggregation of large numbers of human beings."

SPECIAL SIGNALS INDICATING REDUCED SPEED have been suggested for use on English railways to warn enginemen of sharp curves or other points where the rules require trains to be run at reduced speed. Such points are usually noted in the orders given to the men, but may be overlooked, especially at night, and the verdict on the terrible accident at Salisbury a few months ago, contained a recommendation to the effect that more care should be taken to warn enginemen of these dangerous points.

PERSONALS.

Mr. Y. Van den Berg, formerly First Vice-President of the Louisville & Nashville R. R., has been elected a director of the Seaboard Air Line Ry.

Mr. L. M. Shipley has been appointed Superintendent of Terminals of the Chicago Great Western Ry. at Oelwein, Iowa, to succeed Mr. Wm. Matthie, resigned.

Mr. Eben Richards, formerly Vice-President and General Counsel of the Mexican Central Ry., has been elected Temporary President, to succeed Mr. A. A. Robinson, resigned.

Mr. H. I. Miller has been elected President of the Chicago & Eastern Illinois R. R., and also of the Evansville & Terre Haute R. R., to succeed Mr. A. J. Davidson, resigned.

Mr. John R. Anderson has been appointed Assistant Superintendent of the Bureau of Buildings of the Borough of Brooklyn, New York City. He succeeds Mr. Samuel R. Greenblatt, resigned.

Mr. L. M. Ogden has resigned as Superintendent of Construction for the Bush Terminal Co., Brooklyn, N. Y., to accept a position with the General Supply & Construction Co. of New York City.

Mr. W. H. Peterson has been appointed Bridge Engineer of the Chicago & Northwestern Ry., with office at Chicago. He succeeds Mr. W. C. Armstrong, who has been appointed Terminal Engineer.

Mr. R. S. Feuertado, C. E., has opened an office at 1304 Great Northern Building, Chicago, and will make a specialty of reports and estimates on gas, electric, water power and water-works properties.

Mr. P. T. Dunlop, Division Master Mechanic of the Atchison, Topeka & Santa Fe Ry. at Temple, Tex., has been promoted to Mechanical Superintendent at Cleburne, Tex., to succeed Mr. A. Harrity, resigned.

Mr. George Geiger, Superintendent of the Northern Division of the Colorado & Southern Ry., has resigned to become Superintendent of the Denver & Rio Grande R. R. He succeeds Mr. W. E. Miller, and is succeeded by Mr. S. Morris.

Rear Admiral Willard H. Brownson, who has lately taken command of the American naval forces in the East, will, it is understood, soon be made Chief of the Bureau of Navigation, to succeed Rear Admiral Converse. Although Admiral Brownson would, in the usual course, be placed on the retired list next year, on account of age, it is understood that he will be continued at the head of the Navigation Bureau at least during the present Administration.

Mr. L. C. Fritch, M. Am. Soc. C. E., has been appointed Assistant to the President of the Illinois Central R. R. Mr. Fritch entered railroad service in 1884, being employed in the engineering department of the Ohio & Mississippi R. R. In 1892 he was appointed Engineer Maintenance of Way of this company, later being made Division Engineer of the Baltimore & Ohio R. R. He was appointed Superintendent of the Mississippi Division of the Baltimore & Ohio Southwestern R. R. in 1899, and in 1904 entered the service of the Illinois Central R. R., becoming Assistant to the General Manager in 1905.

Obituary.

John O'Brien, General Superintendent of the Buckeye Pipe Line Co., a subsidiary concern of the Standard Oil Co., dropped dead at Howata, Ind. Ter., Nov. 18, of heart disease, aged 43 years. He had been connected with the Standard Oil Co. all his life, becoming Superintendent of the Buckeye Company in June, 1905.

Arthur Tellier, formerly City Engineer of Mason City, Iowa, was drowned in a lake in Southern Alaska, Oct. 12. At the time of the accident he was in the employ of the U. S. Government. Mr. Tellier, with a companion, was crossing the lake, when the boat capsized and both men were drowned.

Elver L. Shinbur, Assoc. M. Am. Soc. C. E., Resident Engineer U. S. Reclamation Service, on the North Platte project, died at Mitchell, Neb., Nov. 7, of typhoid fever. He was born at Oakland, Neb., April 3, 1879, and graduated from the University of Nebraska in 1901. After graduating he accepted a position with the Fremont, Elkhorn & Missouri Valley R. R. as an Instrumentman, and later became Topographer for the U. S. Military Government of Cuba. In May, 1902, he became Assistant Engineer of the Insular R. R., a year later accepting the position of Resident Engineer of the Vera Cruz & Pacific R. R. Mr. Shinbur had been connected with the Reclamation Service since August, 1904, having been Resident Engineer of the North Platte project since August, 1905.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Dec. 3-4. Annual Meeting at New York City. Secy., W. H. Ross, 258 Broadway, New York, N. Y.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Dec. 3-7. Annual Meeting at Mexico City, Mexico. Secy., Chas. O. Probst, M. D., Columbus, Ohio.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 4-7. Annual Meeting at New York City. Secy., F. R. Hutton, 12 West 31st St., New York, N. Y.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.
Dec. 27-Jan. 2, '07. Annual Meeting at New York City. Secy., L. O. Howard, Cosmos Club, Washington, D. C.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Jan. 3. Annual Meeting at Pittsburg, Pa. Secy., F. V. McMullin, 410 Pennsylvania Ave., Pittsburg, Pa.

NATIONAL ASSOCIATION OF CEMENT USERS.
Jan. 8-11. Annual Meeting at Chicago, Ill. Secy., W. W. Curtis, 585 Caxton Bldg., Chicago, Ill.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Jan. 9. Annual Meeting at Boston, Mass. Secy., Mr. Willard Kent, Narragansett Pier, R. I.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 16-17. Annual Meeting at New York City. Secy., C. W. Hunt, 220 West 57th St., New York.

NATIONAL ASSOCIATION OF CEMENT USERS.—Mr. W. W. Curtis, of 585 Caxton Building, Chicago, Ill., has been elected secretary, to succeed Mr. Chas. C. Brown.

NEW YORK RAILROAD CLUB.—The annual meeting of the club was held Nov. 16, at Carnegie Hall, New York City. The treasurer reported a balance of over $13,000 in the treasury, and the secretary a membership of 1,364. The report of the Inspectors of Election showed the following officers elected for the year 1906-1907: President, Mr. H. H. Vreeland; First Vice-President, Mr. J. F. Deems; Second Vice-President, Mr. W. G. Besler; Third Vice-President, Mr. H. H. Hayward; Treasurer, Mr. R. M. Dixon; Executive Member, for three years, Mr. Frank Hedley; Member of Finance Committee, for three years, Mr. Otis H. Cutler.

ENGINEERS' CLUB OF PHILADELPHIA.—At a business meeting of the club held Nov. 3, in the Engineering Building of the University of Pennsylvania, Mr. S. G. Comfort, Chairman of the Nominating Committee, announced the following nominations to be voted upon at the annual meeting in January: President, Mr. Henry H. Quimby; Vice-President, Mr. W. P. Pallett; Secretary, Mr. Walter Loring Webb; Treasurer, Mr. Geo. T. Gwilliam; Directors, Messrs. J. W. Ledoux, John T. Loomis and Emile G. Perrot.

SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.—The first meeting of this new society was held in Cooper Union, New York City, on Friday evening, Nov. 16. A large number were in attendance and greeted the speakers enthusiastically. The meeting was opened by Prof. Milton Higgins, of Worcester, Mass., who briefly outlined the history of the society since its inception last spring, when Dr. Henry S. Pritchett and one or two others, appointed a sub-committee of five men to hold frequent meetings in New York and Boston for the promulsion of industrial education. The objects of these meetings were to bring to public attention the importance of industrial education as a factor in the industrial development of the United States; to provide opportunities for the study and discussion of the various phases of the problem; to make available the results of experience in the field of education both in the United States and abroad, and to promote the establishment of institutions for industrial training. The objects of those meetings are now the objects of the society, the formal organization of which was perfected at the afternoon session, with Dr. Pritchett as President, Mr. Alexander of Lynn, Mass., as Vice-President, and Mr. V. Everit Macy of New York City, as Treasurer. These officers, together with 27 men and women, form the managing body. Prof. Higgins announced that Dr. Pritchett, who was expected to preside, was unable to be present on account of ill health, and Dr. Nicholas Murray Butler of Columbia University, was made chairman for the evening. Dr. Butler stated in his address that the three elements of industrial success were: intelligence and skill; beauty of design; and honesty, soundness and truth. He said that the natural resources of our country were diminishing and before many years inventive faculty must play an important part, so that the time had come for us to lay more stress upon the education of our boys and girls in great industrial and economic problems. The point of application for this work, he said, should be where the elementary school training of to-day leaves off. Mr. Frank A. Vanderlip of New York, followed Dr. Butler with a short address, in which he spoke of Germany as our closest competitor in good industrial educational facilities. Mr. Frederick P. Fish, President of the American Telephone & Telegraph Co., was next on the program. In his address on "Industrial Education as a Means of Developing American Industries," he said there was no progress except by the progress of industries, as this represented the earning capacity of the people. We have no longer with us the trained mechanics of former years because of the introduction of automatic machinery and similar methods to minimize the intelligence of workmen. The man at an automatic machine cannot be changed to another machine, for his education has not been such that he understands the different steps of manufacture. He should be educated to understand his work so well that he can look for improvements and know the real results of machinery. The large manufacturing concerns have set a good example in educating men in their work, but they can touch only a few. The Society should enlarge on this work. Men thus educated will be more useful to themselves and to the world, but they may even then fail to draw more pay or be promoted on account of lacking a few elements of leadership. This, however, should not discourage them. Mr. Alfred Mosely spoke for England's submerged tenth. He said that the neglected scientific education of the English people had placed 13,000,000 of them on the verge of starvation. To improve this condition he had invited British teachers to investigate American methods of industrial education and that between now and March about 500 of them will come over to study the problem. Samuel B. Donnelly spoke as a representative of the laboring men. He deplored the existing conditions, and said that the rag-time production of the present was due to mechanics knowing nothing of theory. The meeting closed with an interesting address by Miss Jane Addams of Hull House, Chicago, who discussed the relation of art to industry.

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